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NOVEMBER 1949

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LITERATURE

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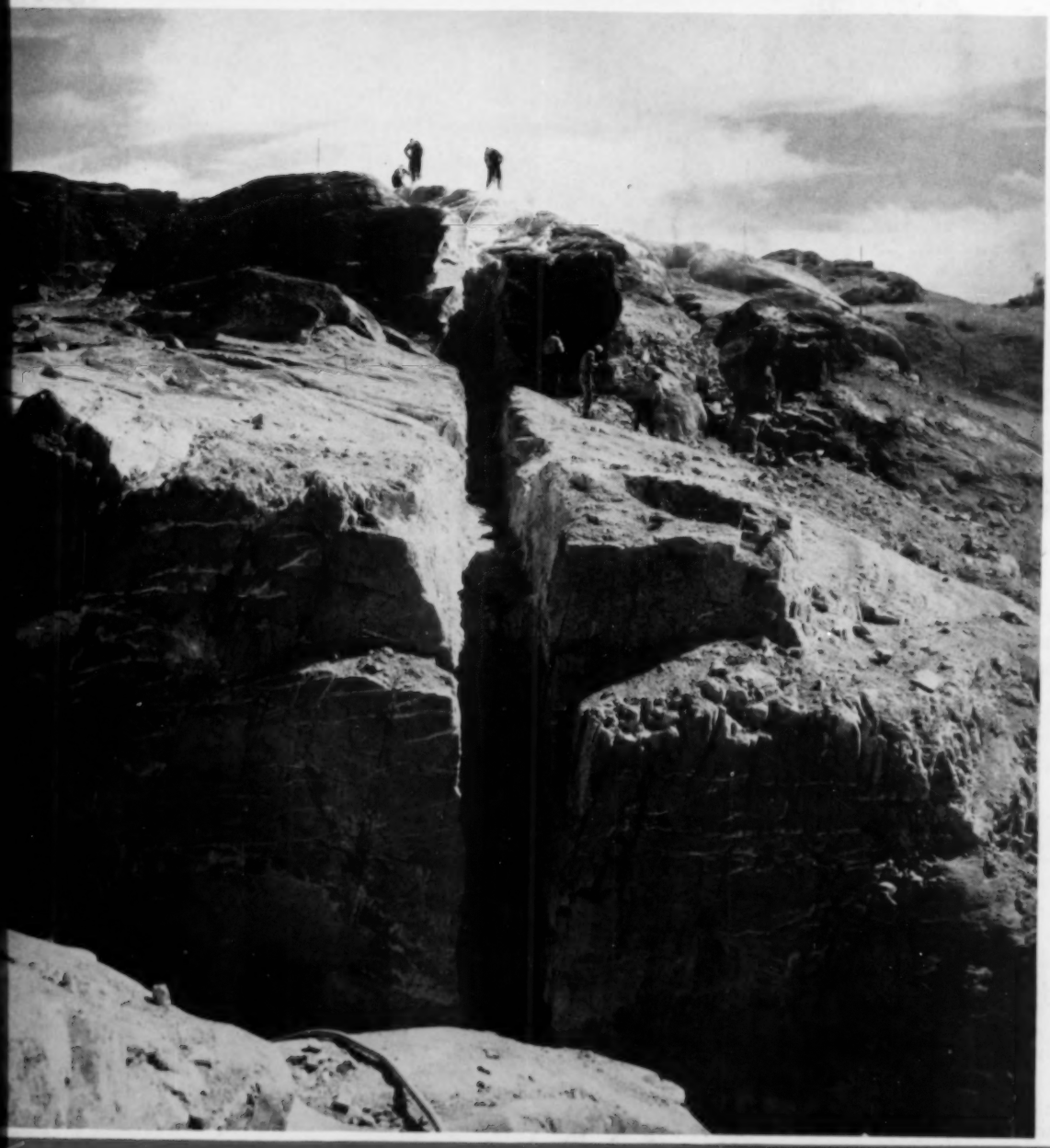


DRILLING TRENCH FOR CUTOFF WALL

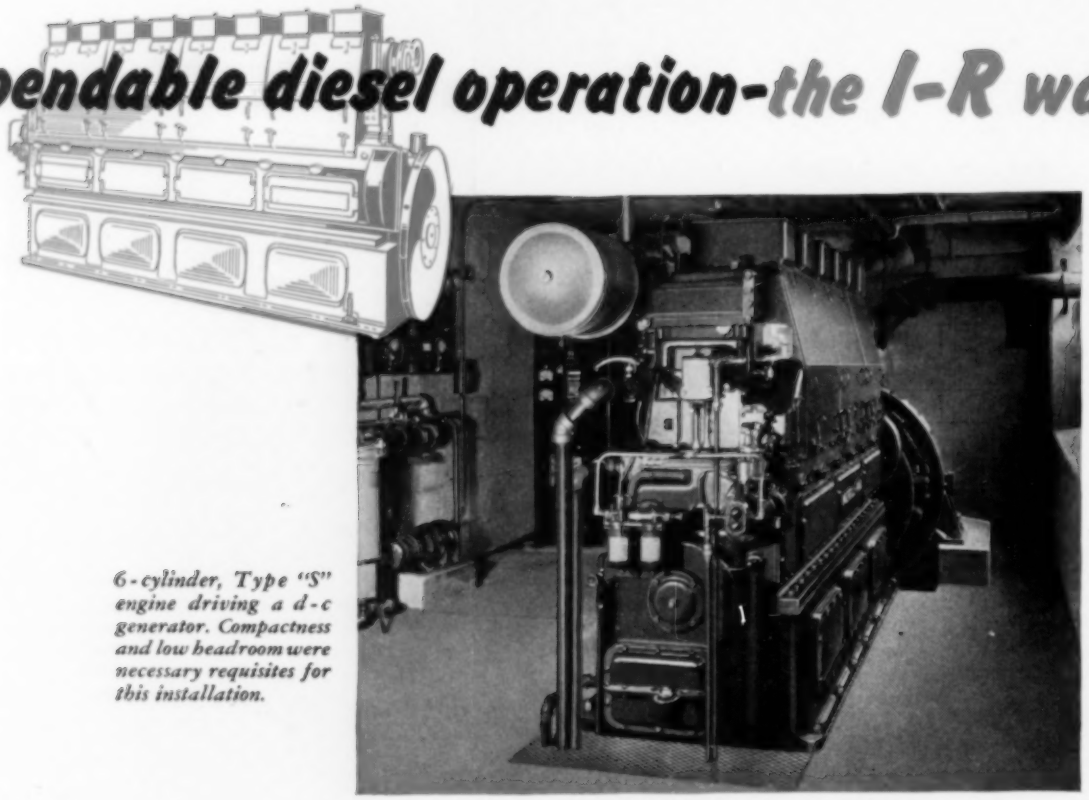
Jackhamer and powder men starting work on North Dam of Columbia Basin Project

PHOTO, U. S. BUREAU OF RECLAMATION

VOLUME 54 • NUMBER 11

NEW YORK • LONDON

dependable diesel operation-the I-R way-

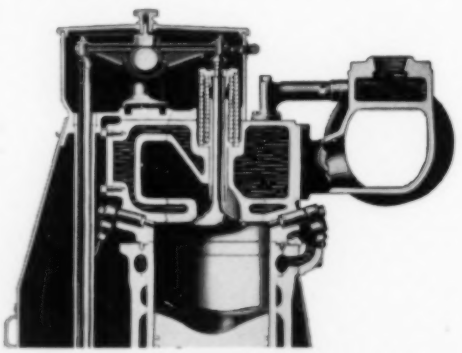


6-cylinder, Type "S" engine driving a d-c generator. Compactness and low headroom were necessary requisites for this installation.

Dependability in a Diesel engine is something that is hard to describe. It's really the result of many good design features.

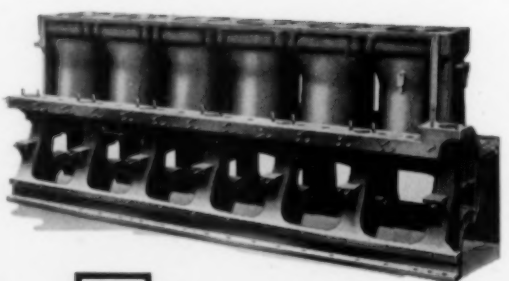
For instance:

DEPENDABLE operation results from the advanced design of the cooling system in Ingersoll-Rand Diesels. High-velocity flow of cooling water past areas of highest temperature achieves exceptionally good cooling with minimum water. Moving upward around the cylinder, the water is forced through two reduced channels encircling the top of the cylinder. This *increased velocity* means more heat pick-up. From the cylinder jackets the water is then carried to the cylinder head by a short jumper which directs the water across the "floor" of the cylinder head and around the valve seats. Here again, directed cooling improves heat pick-up.



DEPENDABLE operation of Ingersoll-Rand Diesels is also insured by the one piece cast cylinder block and upper crankshaft housing. This one piece construction not only assures maximum rigidity with minimum frame weight, but it means that crankshaft deflection is held to a minimum. Here is a factor that directly increases main bearing life.

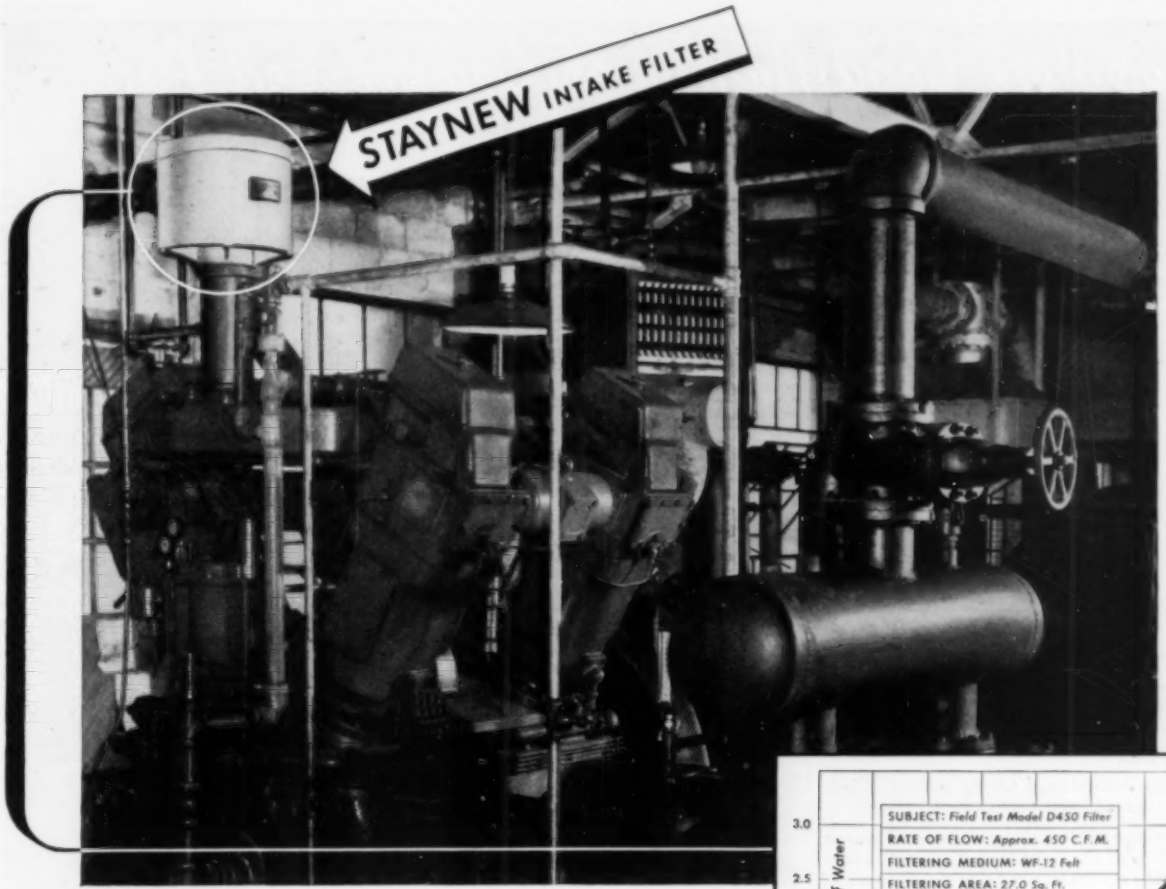
If you would like to find out more about the dependability and economy of these outstanding Diesels, ask your local Ingersoll-Rand office for a copy of Bulletin 10310. Sizes range from 225 to 600 hp for the unsupercharged Type "S" and 675 to 900 hp for the supercharged Type "SS" engines.



Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 163-7

COMPRESSORS • AIR TOOLS
ROCK DRILLS • TURBO BLOWERS
CONDENSERS • CENTRIFUGAL PUMPS
OIL AND GAS ENGINES



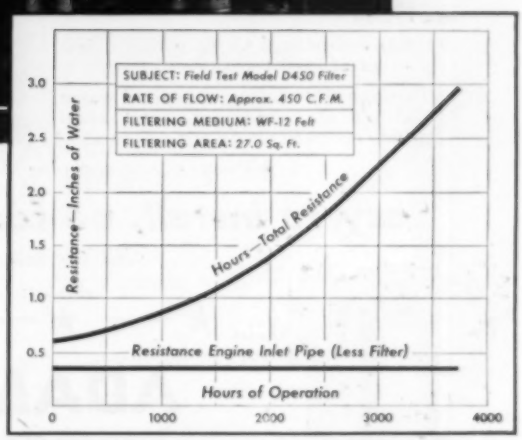
3761 HOURS CONTINUOUS OPERATION WITHOUT ATTENTION

Yet Filter Resistance Is Only 2.73 Inches of Water

This filter, installed on a Diesel-powered compressor, operates under unusually severe conditions. Intake air is heavily loaded with dust and oil; the dust due to the close proximity of a railroad siding where bulk lime, sand, and coal are handled—the oil to two additional Diesel-powered compressors operating in the same room.

Such a case history is not unusual. Reports are frequently received of Staynew Filters operating under less severe conditions for two or more years without attention—with the initially high efficiency rising as dust load increases.

Ease of cleaning as well as infrequency of cleaning is also an important feature, requiring only a few minutes with the specially designed Staynew Cleaning Nozzle.



More and more experienced operators of compressor and engine equipment specify Staynew Intake Filters—not only because of the minimum attention required, but also because these filters:

- ★ **Provide positive protection**
- ★ **Require no pre-coat or filter aid**
- ★ **Are unaffected by extremes of temperature**
- ★ **Permit use of oversize filters (air velocity not critical)**
- ★ **Are ideal for use with carbon ring compressors**

DOLLINGER PROTECTOMOTOR STAYNEW FILTERS

DOLLINGER CORPORATION

7 CENTRE PK., ROCHESTER 3, N. Y.

IN CANADA: McCARTHY AND ROBINSON TORONTO, ONT. ★ ENGINEERING EQUIPMENT CO. MONTREAL, QUE.

Complete Conditioning of Compressed Air

by ADAMS PIPELINE

AFTER COOLER and AIR FILTER

Thousands in use in Leading Industries
RESULTS GUARANTEED

ADAMS Aftercooler and Cyclone Separator

ACTION

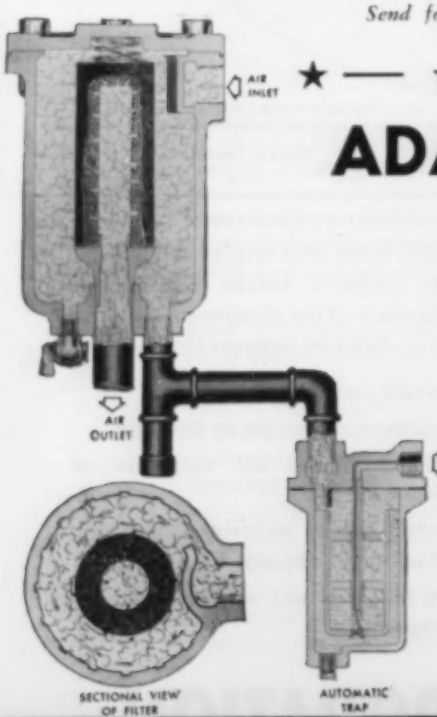
- Cools compressed air to within a few degrees of cooling water
- Through this cooling, vaporized water and oil are condensed — and completely removed by Cyclone Separator

BENEFITS

- The dry, clean air prevents failing of instruments
- Reduces wear and tear on air tools and pneumatic machinery
- Prevents freezing pipes in winter
- Prevents rust and pipe scale in distribution lines

Easy to install, no foundation required

Send for Bulletin 704



ADAMS PORO STONE Air Filters

Protect Instruments and Air Tools —Insure Better Work

The Adams Poro-Stone Filter gives continuous service without attention or maintenance expense. Efficient centrifugal separation *plus* diffusion through Poro-Stone, removes liquid and solid contamination completely without pressure loss.

Automatic Trap eliminates attention and assures continuous and efficient filter operation.

Learn how Adams Conditioning means Trouble-free use of Compressed Air

Send for Bulletin 105, and accept our 30-day FREE TRIAL on ADAMS Poro-Stone Air Filters.

R. P. ADAMS CO., INC.

209 E. PARK DRIVE
BUFFALO 17, N. Y.

AVAILABLE FROM NORTON . . .

the Most Complete Abrasive Service in the World

VARIETY—abrasives for polishing, tumbling and lapping, grinding wheels, segments, bricks and sticks, coated abrasives* and sharpening stones* to meet *all* demands of industry.

DISTRIBUTION—grinding wheel distributor stocks in over 300 cities throughout the world, warehouse stocks in five industrial centers of the United States, factory stocks at the main Worcester plant and at the Norton plants in Canada, England, Australia, France, Germany and Italy.

ENGINEERING—a Norton field staff of abrasive engineers and Norton factory specialists co-operating with over 2,500 distributor representatives the world over.

RESEARCH—a staff of over 135 trained scientists and technicians in well-equipped laboratories—constantly developing new abrasives, new bonds and improved manufacturing processes.

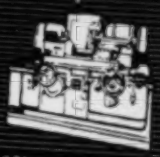
*Products of Behr-Manning Division

NORTON

NORTON WAREHOUSES

CHICAGO · DETROIT · PITTSBURGH · CLEVELAND · PHILADELPHIA

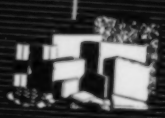
GRINDING WHEELS



GRINDING MACHINES

REFRACTORIES

NORBIDE



NON-SLIP FLOORS

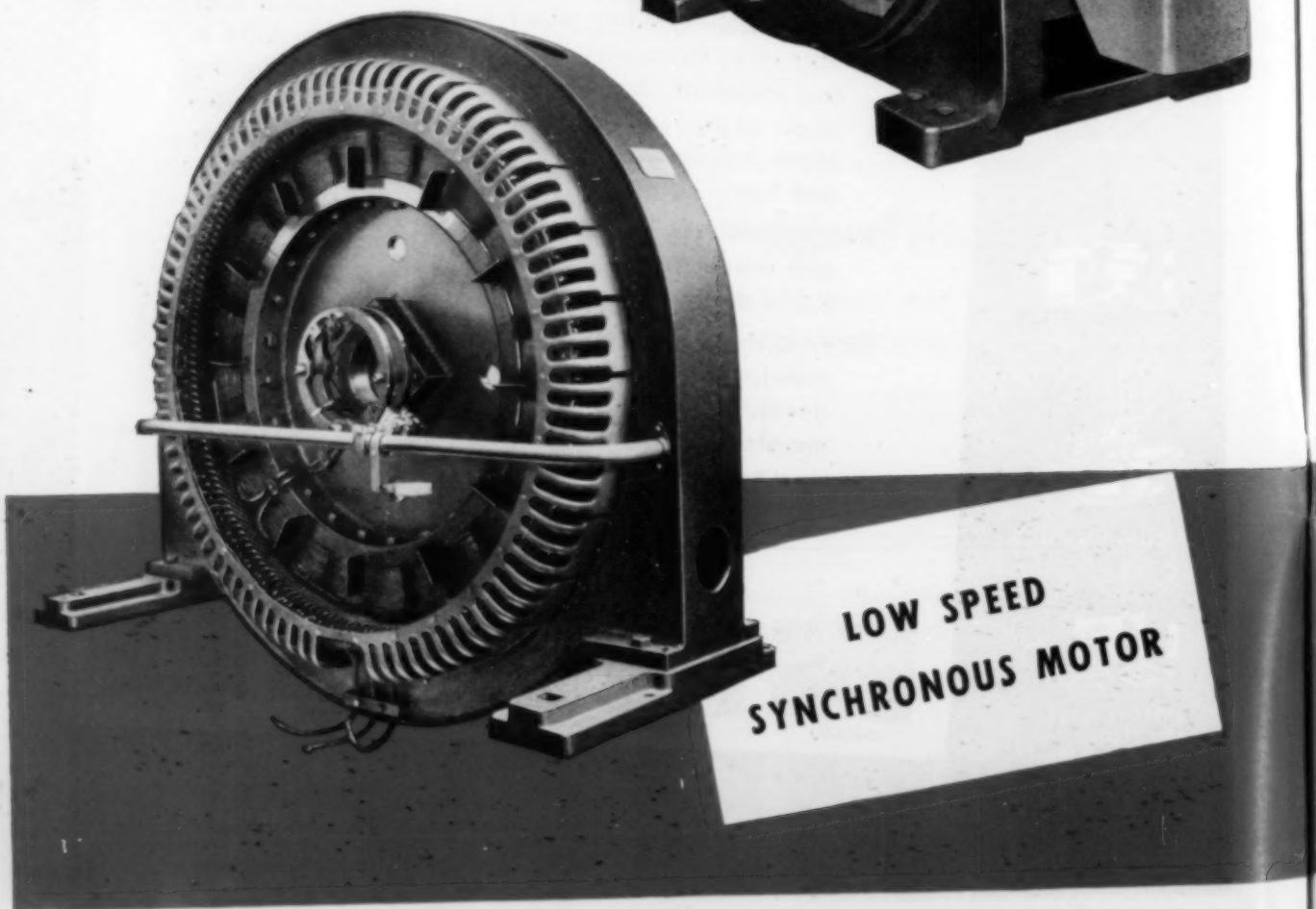
LABELING MACHINES

ABRASIVE PAPER AND CLOTH · · · SHARPENING STONES

NORTON COMPANY • WORCESTER 6, MASS.

(Behr-Manning, Troy, N. Y. is a Norton Division)

SAVE ON POWER BILLS



WITH GENERAL ELECTRIC SYNCHRONOUS MOTORS

SYNCHRONOUS MOTORS IMPROVE POWER FACTOR

1. **Save you penalty charges for poor power factor**

2. **Release needed generating capacity**

Here's an example:

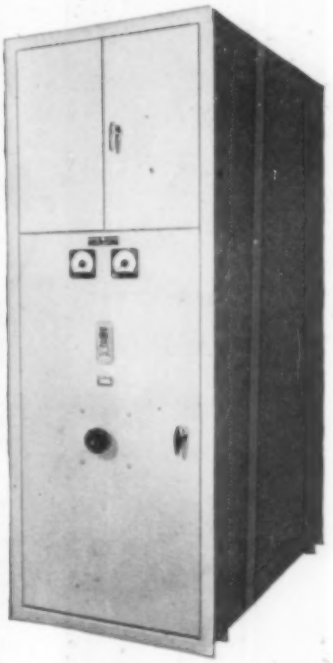
One mill improved power factor from 72 per cent to 84 per cent by installing a 300 hp .8 leading power factor G-E synchronous motor in place of another motor. This corrected power factor released 260 kva capacity in their generating equipment and allowed installation of additional motors.

These savings in cost of operation are available to you.

Savings in the initial cost of equipment are also available—when synchronous motors are used in their natural fields of application. To find out about these natural fields of application, get in touch with our nearest office.

REMEMBER—General Electric Synchronous motors—whenever you need constant speed. They can give you lower initial cost, lower operating cost. For bulletin information, fill in the coupon:

G-E SYNCHRONOUS MOTOR CONTROL MAKES SURE



G-E synchronous control provides the accurate adjustments that enable you to improve power factor. Here's where details count—where the slightest variation of a pointer on a meter means money saved—or lost. And General Electric has not overlooked these elements. Consider the meters for a moment. Here, G-E has devised a long scale with the pointer in the same plane as the figures so there can be no possibility of misreading the instrument. Anti-glare glass is used so no distortion is possible.

The new smaller rheostat, too, has design features that not only result in longer life but in greater operating convenience and accuracy. The handle has been molded to fit the fingers of the operator—to prevent slippage and over correction. You can be sure, too, that the new field circuit will respond instantly to rheostat adjustment.

Protection is assured the operator through the attractive steel enclosure. The cabinet resists blows, keeps out dirt and other operating hazards. All live parts are strongly guarded. Plant appearance is improved with this control designed to line up with other G-E power units such as switchgear. Ask your nearest G-E office for more information about this equipment that safeguards your investment . . . helps save operating expenses.

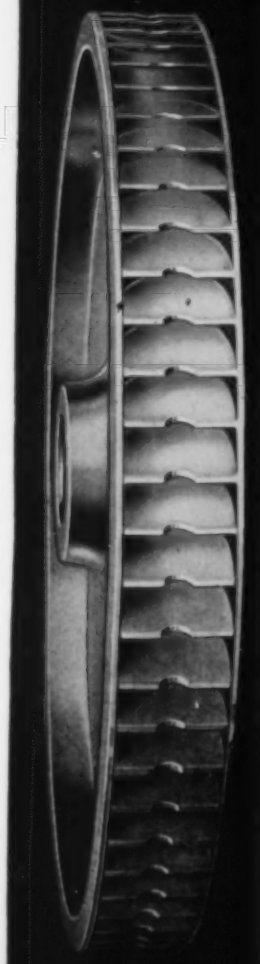
Apparatus Dept., Sec. F770-6, General Electric Company
1 River Road, Schenectady, New York

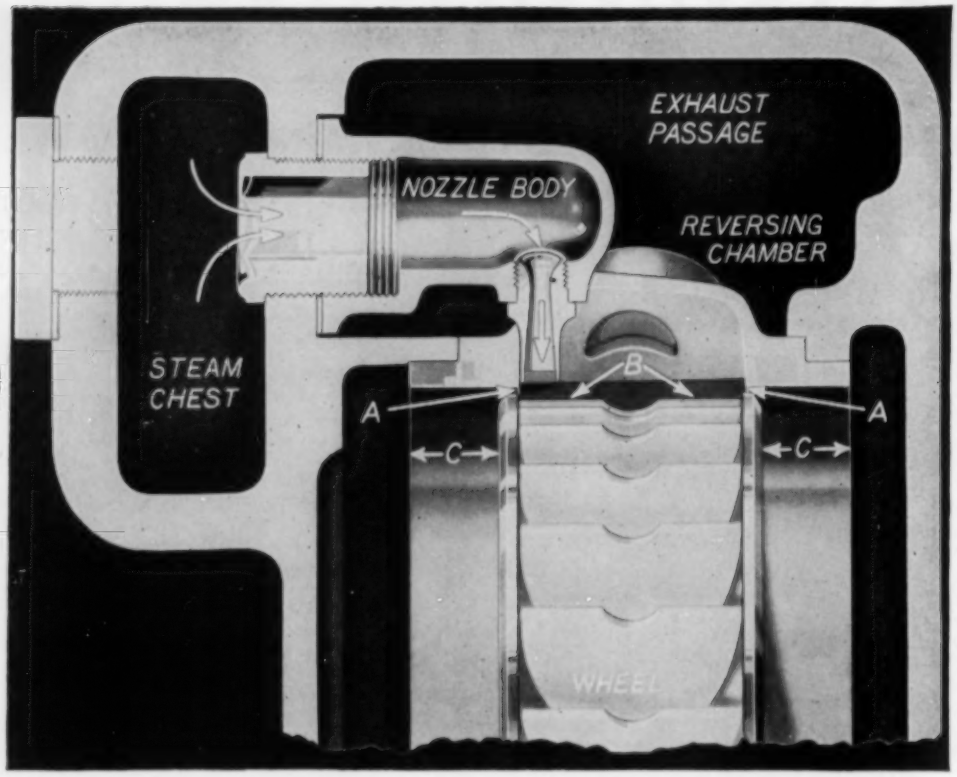
Gentlemen:
Please send me: ☐ GEC-505, Synchronous Motor Control ☐ GEA-5113, High-speed Synchronous Motors ☐ GEA-529D, Low-speed Synchronous Motors

Name ..... Company .....
Street ..... City .....
State .....

GENERAL ELECTRIC

TERRY





AMPLE CLEARANCES FOR DEPENDABILITY

Large blade and rim clearances and extra large side clearance — one inch — help make Terry One-piece Wheel Turbines highly dependable in operation.

The blades cannot foul because of the protection afforded by the rims, which are not damaged, should rubbing occur.

Note the rim clearance, AA in diagram. Also the large blade clearance, B. Side clearance, CC, is so large that end-play from external thrust cannot damage wheel.

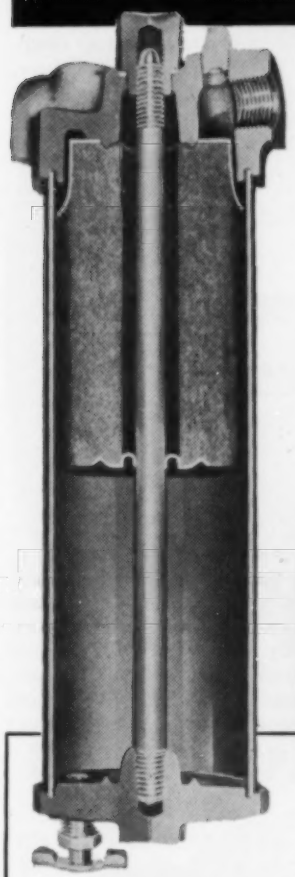
Terry Bulletin S-116 will give you full information on the Terry Wheel Turbine. A request on your business letterhead will bring you a copy.

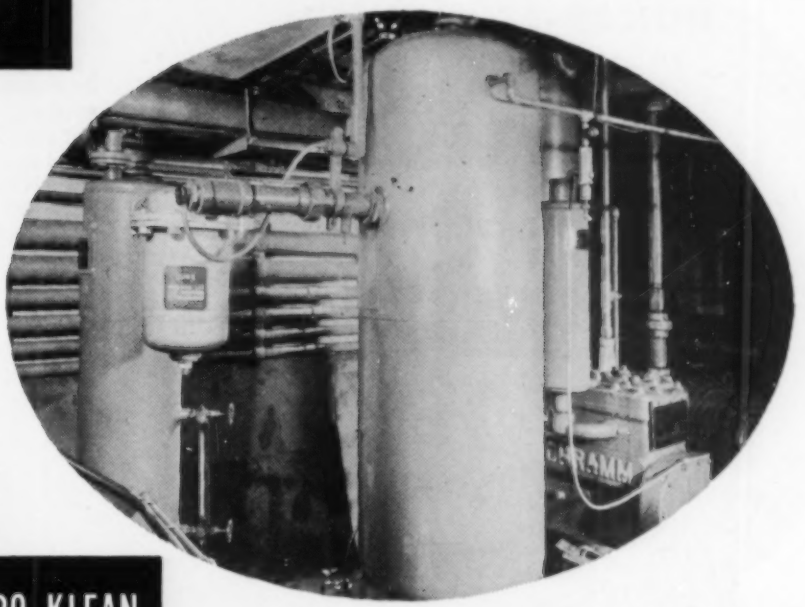
T-1171

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Operation—"Air-Conditioning"

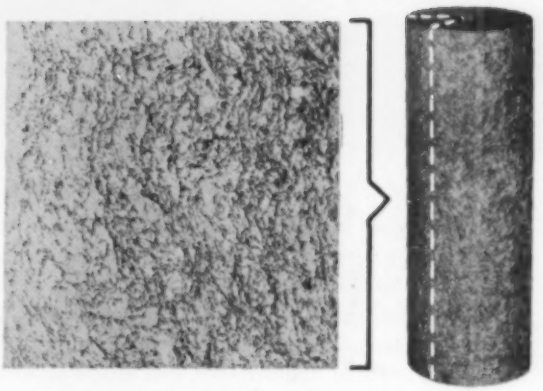
Dependable laboratory experiments require standardized materials and conditions. Sun Oil Company standardizes laboratory compressed air by removing oil, water, and other contaminants with a Cuno Micro-Klean Filter. Handling 150 cfm (free air) at 100 psi, the Micro-Klean provides the uniformly conditioned air vital to the accuracy of innumerable tests and experiments.





HOW MICRO-KLEAN COUNTERS CONTAMINATION

Air passing into the MICRO-KLEAN Filter first hits the baffle, deflecting some of the moisture down outside the cartridge. Any moisture remaining enters the cartridge where it must make hundreds of sharp turns, impinging on the non-wicking fibres, then draining into the extra-large collection chamber.



No Wicking or Channeling

An exclusive method of "felting" fibres creates a network of tiny interstices in the cartridge. "Graded density in depth" prevents clogging, doubles dirt-collecting capacity. Resinous impregnation and polymerization eliminates "wicking" and strengthens the cartridge, preventing channeling.

OTHER USES AS STANDARD EQUIPMENT: pneumatic machinery, spray painting, powder dispensing devices, etc. Models to handle volumes in excess of 450 cfm, pressures to 125 psi.

●Your nearby Cuno engineering representative, handling the broadest line of fluid filters, is your best source of unbiased recommendations on fluid filtration . . . he offers you, before and *after* installation, service based on years of experience with engineering filtration systems.

CUNO

Fluid Conditioning

Removes More Sizes of Solids from More Types of Fluids

MICRONIC • DISC-TYPE • WIRE-WOUND

CUNO ENGINEERING CORPORATION
1711 S. Vine Street, Meriden, Conn.

Please send information on Cuno Filter.

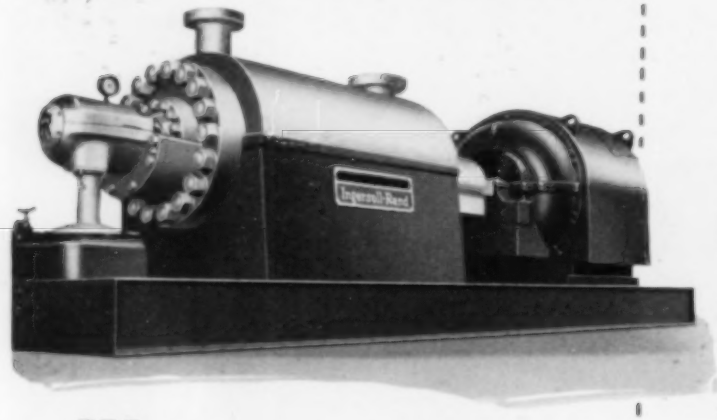
Name.....

Position.....

Business Address.....

PLEASE ATTACH COUPON TO YOUR BUSINESS LETTERHEAD

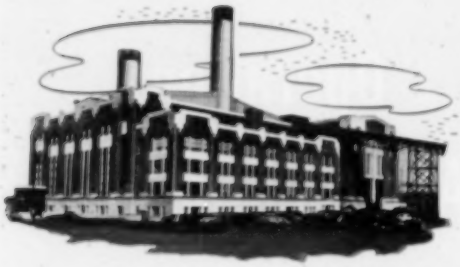
HERE'S WHY
Ingersoll-Rand
BOILER-FEED PUMPS
are
FIRST CHOICE
for really
HIGH PRESSURES



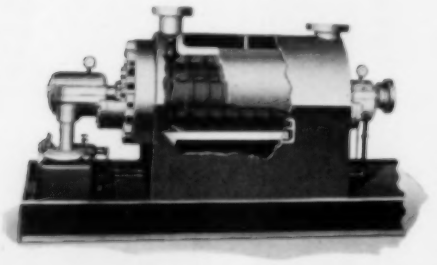
When so many leading Central Stations repeatedly specify Ingersoll-Rand boiler-feed pumps for the highest operating pressures in use today, you can be sure there are good reasons for this preference. Here are three of them—*dependability, ease of maintenance,* and *appearance*—all important considerations in the modern, high-pressure steam generating plant.

I-R high-pressure boiler-feed pumps, Class CHTA and CHTB, are multi-stage, single-suction, diffusor-type units, built for discharge pressures of from 1000 to 3000 psi—in capacities to 2800 gpm at temperatures up to 800° F. But *whatever* pressure or capacity you need, Ingersoll-Rand can supply a boiler-feed pump for the job. I-R engineers will be glad to help you select the pump that best meets all of your specific requirements.

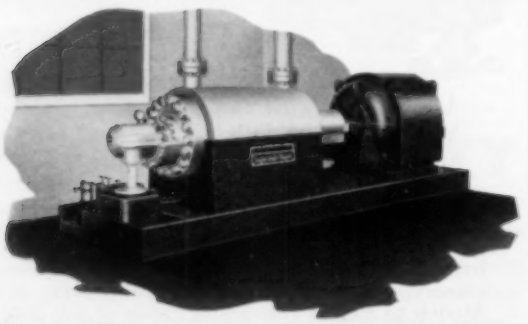
***FOR COMPLETE** information on Class CHTA and CHTB high-pressure boiler-feed pumps call the nearest Ingersoll-Rand branch office. Ingersoll-Rand manufactures all types and sizes of centrifugal pumps.*



DEPENDABILITY is probably the most important single requirement in all central station equipment. And here, I-R double-case boiler-feed pumps have chalked up a record that speaks for itself. Many of these high-pressure units have been in service for over 12 years—with little or no attention! And more than 40% of the units sold are on *repeat* orders—from users who have already proved this dependability in their own plants.



EASIER MAINTENANCE, and less of it, is an inherent feature of the new I-R Class CHTA and CHTB pumps. They are of "double-case" construction which permits maximum accessibility and greatly simplifies regular maintenance procedure. You save hours, or even days of "down-time" on dismantling and assembly operations too, because the entire inner casing assembly can be removed as a unit in a surprisingly short time.

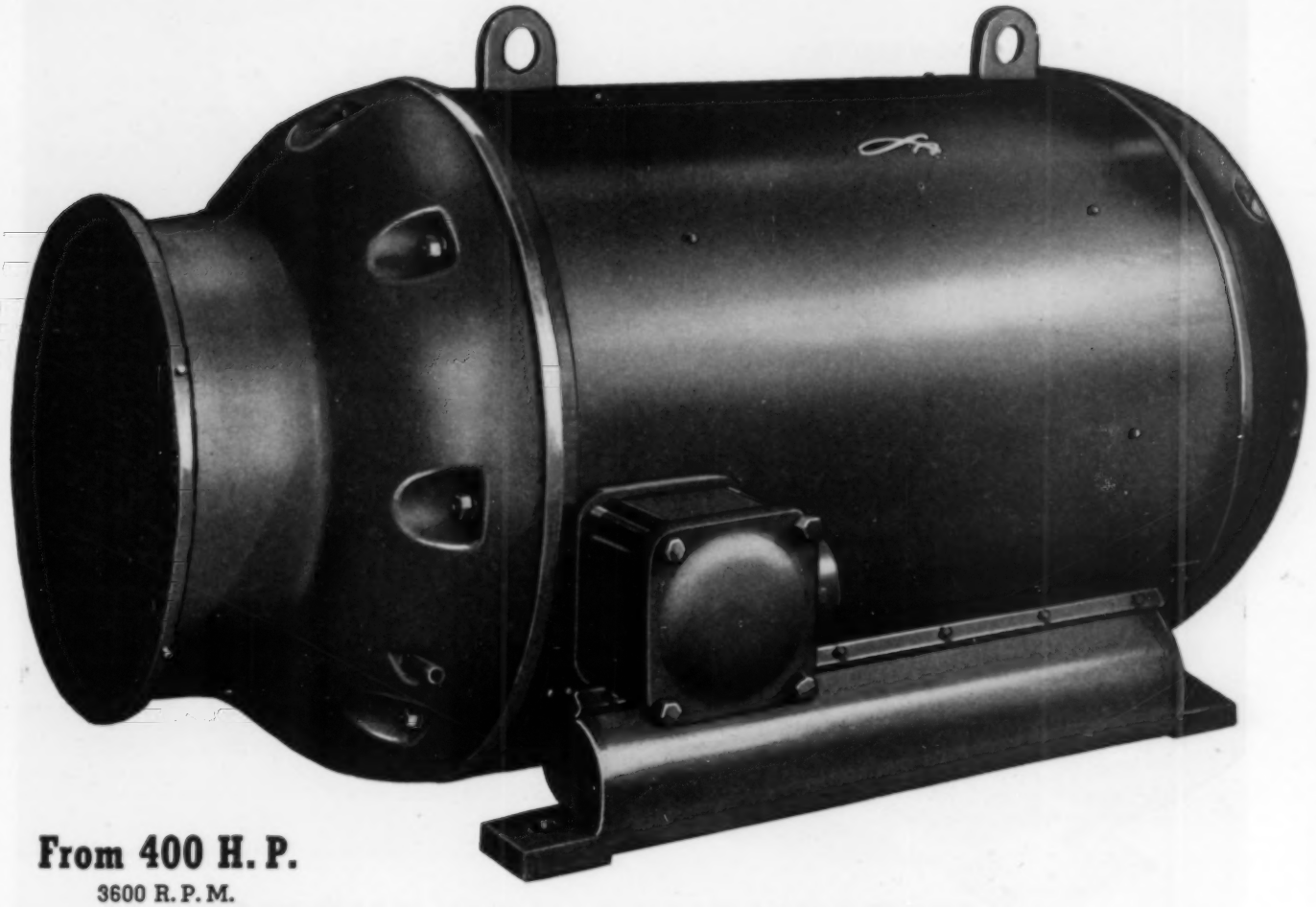


APPEARANCE is becoming an increasingly important factor in the modern Central Station. And the sleek, streamlined design of I-R boiler-feed pumps is entirely in keeping with the trend in modern equipment. Many of the lubricating system components have been integrated into one compact assembly, thus eliminating much external piping. Sheet metal lagging over the casing blends in with the main pump support.

Ingersoll-Rand

Cameron Pump Division
11 Broadway, New York 4, N. Y. 389-10

COMPRESSORS · AIR TOOLS · ROCK DRILLS · TURBO BLOWERS · CONDENSERS · CENTRIFUGAL PUMPS · OIL AND GAS ENGINES



From 400 H. P.

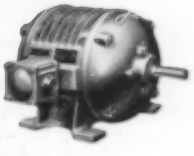
3600 R. P. M.

Type EX, Frame 8095, 2300 volt, 3 phase, 60 cycle, totally-enclosed, fan-cooled, explosion-proof motor.

Down to 1/2 H. P.

1800 R. P. M.

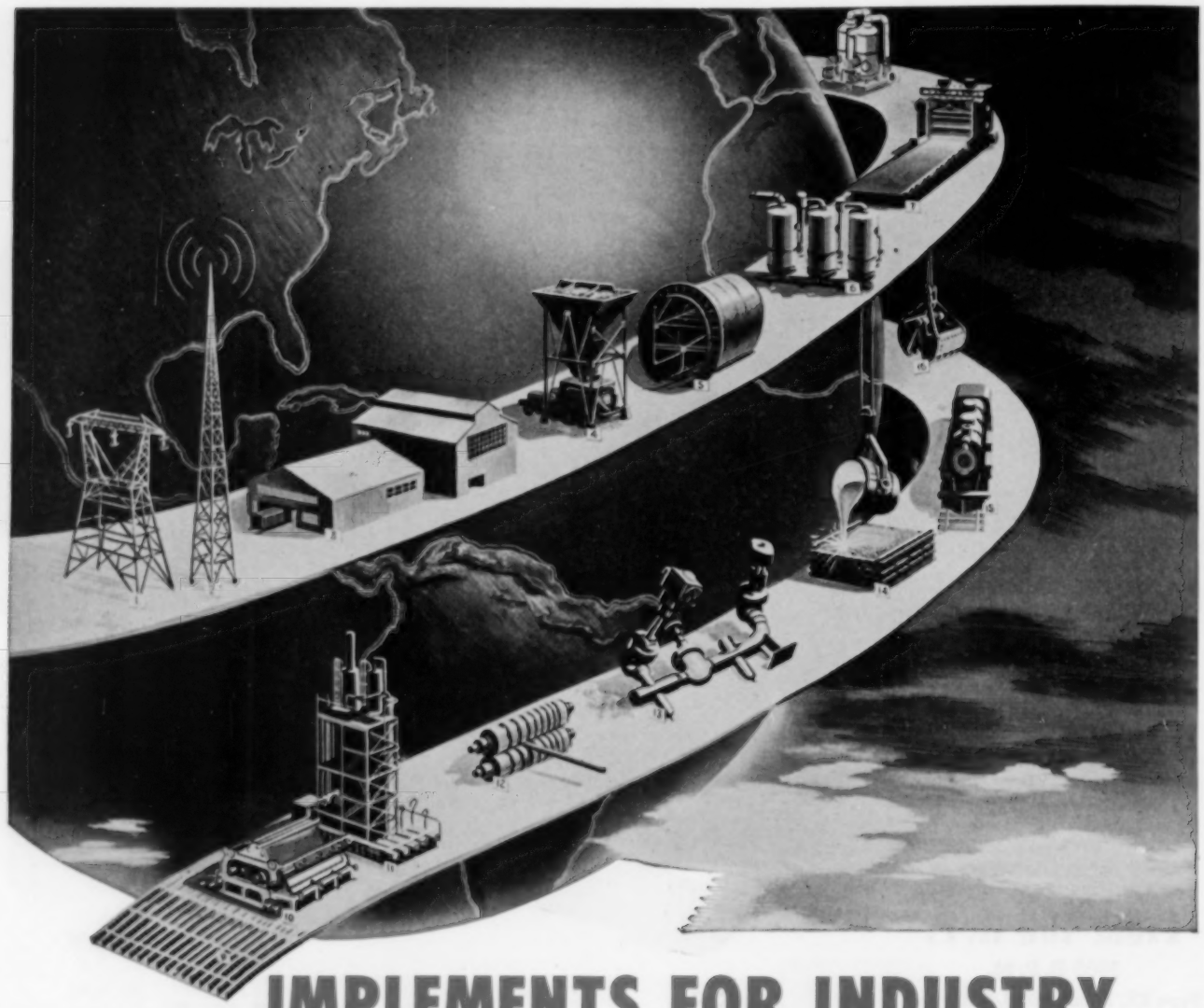
Type EIX, Frame 163, 220 volt, 3 phase, 60 cycle, totally-enclosed non-ventilated explosion-proof motor.



Did You Know?

. . . that The Louis Allis Co. originated, developed and pioneered the first fan-cooled explosion-proof electric motor—and makes a COMPLETE line of alternating current explosion-proof motors—from 1/2 to 400 H. P.—in a wide variety of electrical and mechanical specifications?

THE LOUIS ALLIS CO., MILWAUKEE 7, WISCONSIN



IMPLEMENTS FOR INDUSTRY

THE ILLUSTRATION presents a partial idea of Blaw-Knox Products and Services.

1. Transmission Towers
2. Towers for Broadcasting and Communications
3. Industrial Buildings
4. Construction Equipment
5. Steel Forms for Concrete Construction
6. Chemical and Process Equipment
7. Rolling Mills and Equipment
8. Gas Cleaners
9. Open Steel Flooring
10. Food Processing Machinery
11. Complete Chemical Plants
12. Rolls for Rolling Mills
13. Prefabricated Power Piping
14. Alloy Castings
15. Castings for Locomotive Frames, Crossheads and Wheel Centers
16. Clamshell Buckets

ALL OVER THE WORLD!

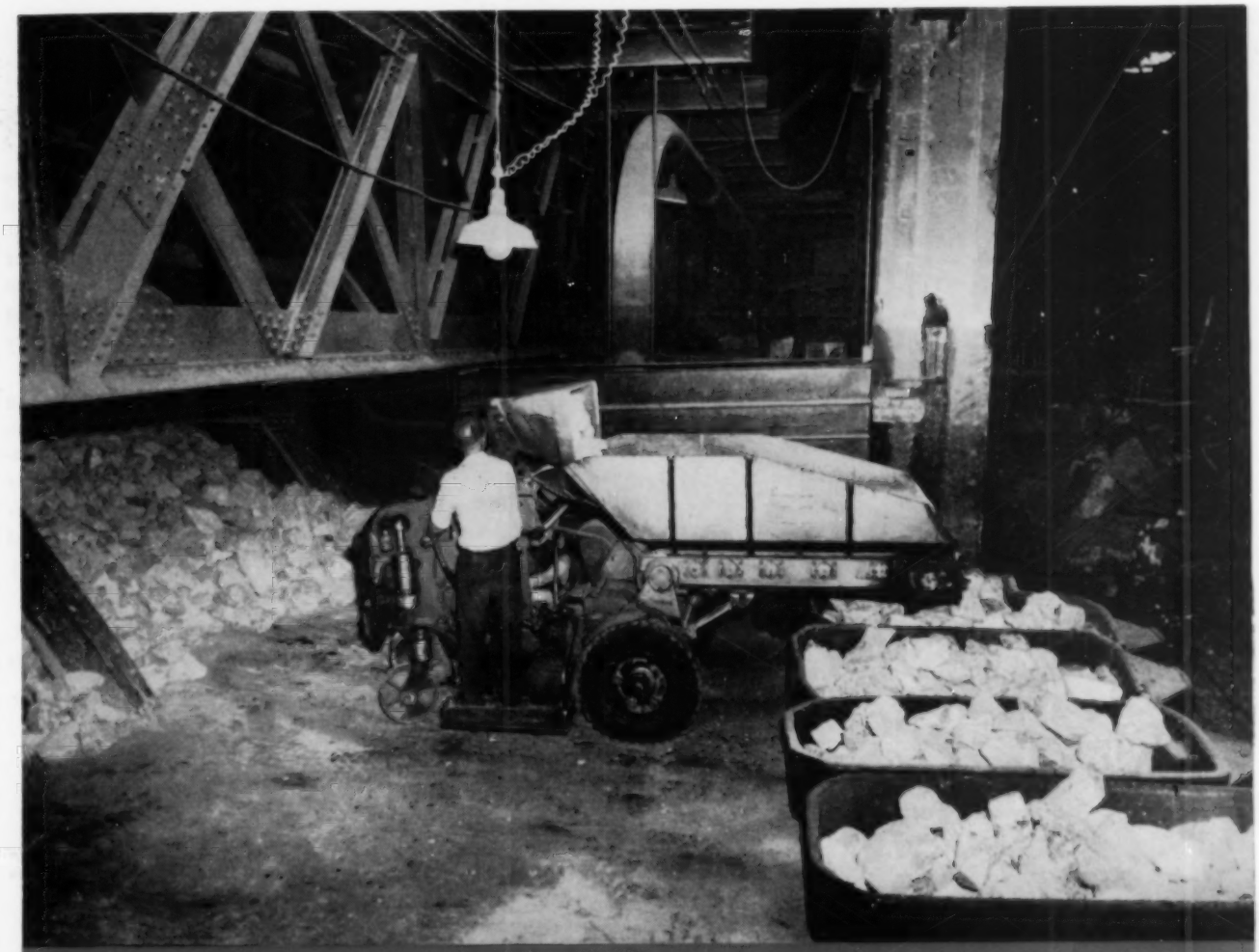
Practically everywhere in the world, Blaw-Knox engineering skill, facilities, products and "know-how" are serving industry.

If yours is a problem of low-cost production, modernization or new development — call on Blaw-Knox. Your inquiry will receive executive attention, regardless of where you may be located.

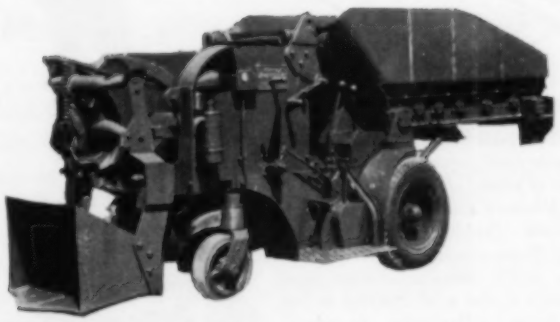
BLAW-KNOX COMPANY

PITTSBURGH, PENNSYLVANIA, U.S.A.

ADDRESS . . . BLAW-KNOX EXPORT DEPARTMENT • Section 2047 Canadian Pacific Bldg.
342 Madison Ave. • New York 17, New York CABLE ADDRESS: BLAWKNOX, N. Y.



Dig it — Load it — Haul it — with the same unit



The Model 15 RockerShovel is supplied with three style hoppers; one with horizontal conveyor hopper is shown above. It is available with electric or gasoline motors and with steel, solid rubber, or pneumatic tires. Eimco Engineers will assist you in selecting the proper combination for your job.

Wide awake industrialists are looking to the Eimco Model 15 RockerShovel for savings in material handling. For digging into rock, sand, gravel, loading the hopper full and hauling it to discharge point this machine is fast and economical. The Model 15 works in narrow places, does not turn around to hump. It is easily controlled, moves forward or reverse with the same speed and will pivot turn or will describe any radius turn desired.

The Model 15 is a heavy duty machine constructed of heavy alloy steel castings and plate. Material handling capacity depends on the application, but will average about 45 ton per hour.

Write for Bulletin L-1013

EIMCO

THE EIMCO CORPORATION

The World's Largest Manufacturers of Underground Rock Loading Machines

EXECUTIVE OFFICES AND FACTORIES — SALT LAKE CITY 8, UTAH, U. S. A.

BRANCHES: NEW YORK, CHICAGO, BIRMINGHAM, EL PASO, BERKELEY, DULUTH

AFFILIATED COMPANIES: SOCIETE EIMCO, PARIS, FRANCE
EIMCO (GREAT BRITAIN) LTD., LEEDS 12, ENGLAND

AGENTS IN ALL PRINCIPAL CITIES THROUGHOUT THE WORLD

A216

If it's piping for power plants

. . . It's in the CRANE line

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

Take This Boiler Feed Water Installation, for example. Crane supplies the valves, fittings, pipe and accessories needed to keep this . . . or any other system . . . at peak efficiency. You get everything for the job on one order . . . get better service, too. For no matter where you're located, Crane serves you locally through well-stocked, cooperating Branches and Wholesalers, all backed by large factory stocks.

To standardize on this **Single Source of Supply**—the world's most complete—is to simplify all piping procedures, from design to erection to maintenance. **One Responsibility** for materials . . . whether in brass, iron, steel or alloys . . . helps you to get a better installation, on schedule. **One Standard of Quality** for every item in the broad Crane line assures dependable performance from every part of your piping system.

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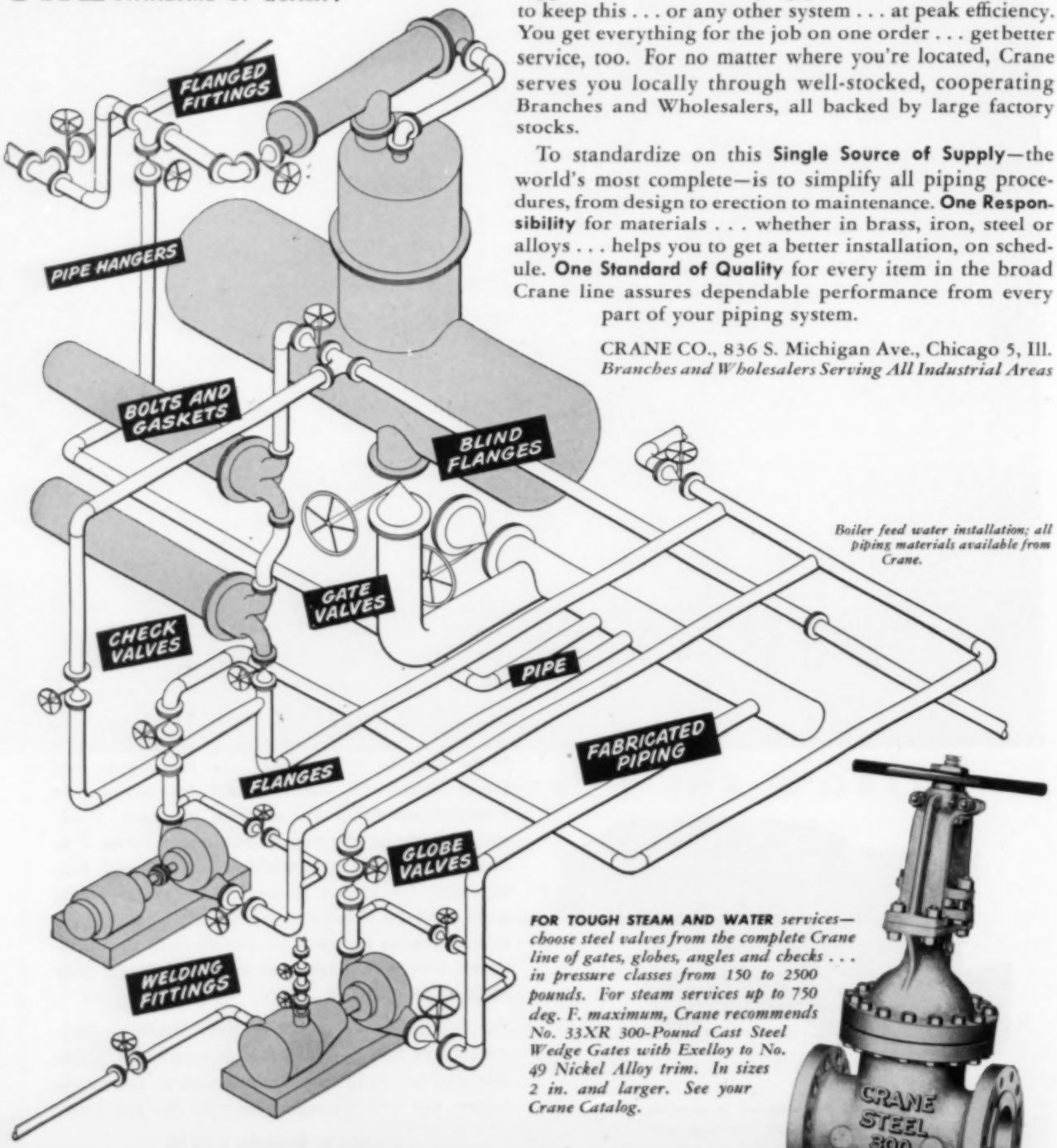

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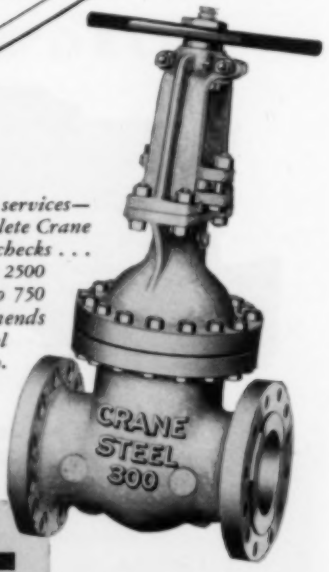

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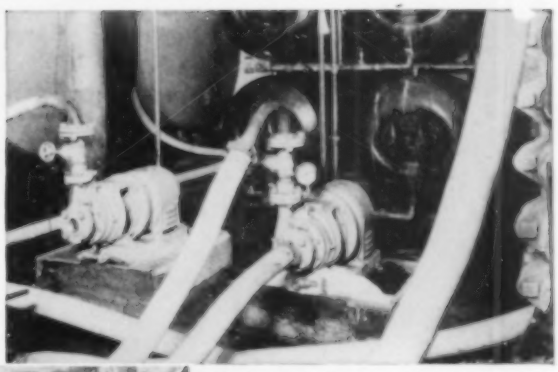
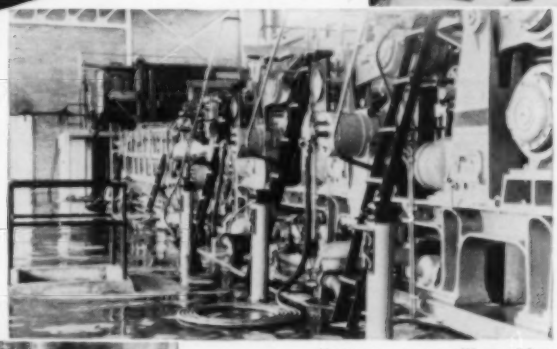
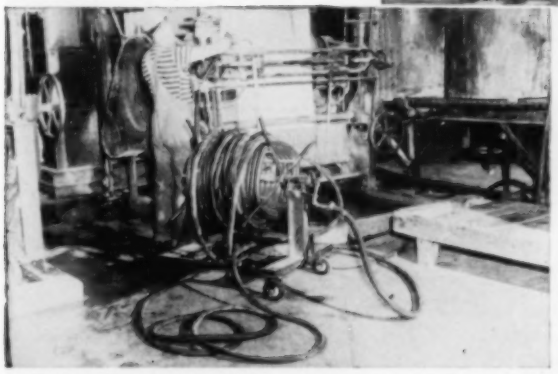


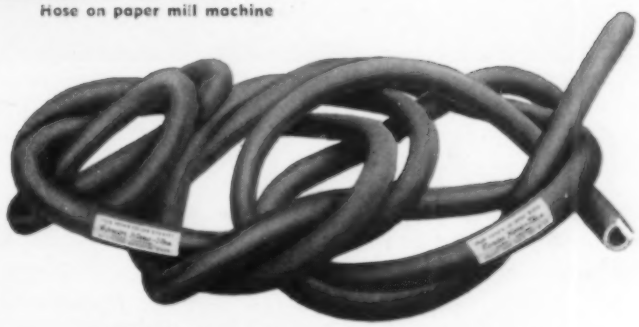
Hose on stationary carbonating pumps



Hose on paper mill machine

Hose for cleaning by air





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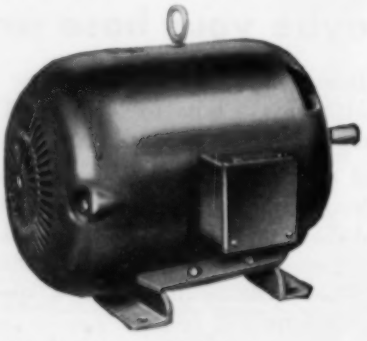

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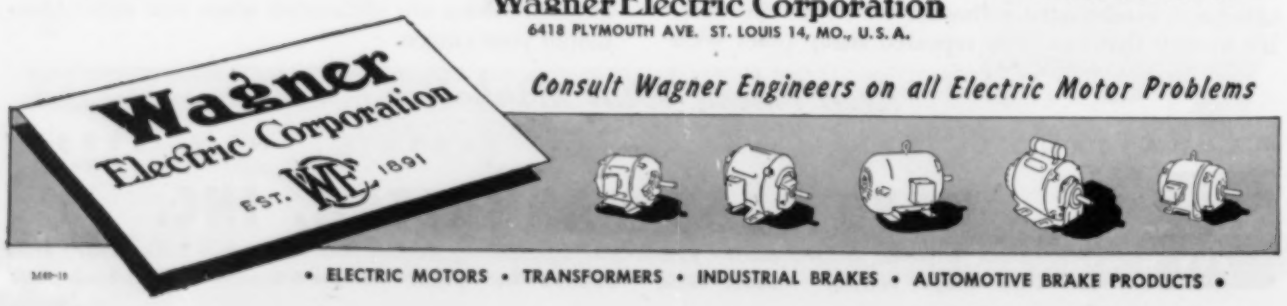

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ON THE COVER

TWO miles from Grand Coulee Dam, in the State of Washington, J. A. Terteling & Sons, Inc., is constructing for the Bureau of Reclamation an earth-and-rock dam in the spacious Upper Grand Coulee that was carved by the Columbia River in past ages. Known as North Dam, it will form the northern retaining barrier of a 27-mile-long equalizing reservoir that will play a part in distributing the water stored behind Grand Coulee Dam to great tracts of land that are now cropless. Three other dams are included in the huge irrigation system, which is expected to go into operation in the spring of 1952

•

IN THIS ISSUE

EVER since Franklin's historic kite-flying experiments men have speculated on the exact mechanics Nature utilizes in creating lightning. Now, after 200 years, a group of scientists in New Mexico is approaching the answer. Our leading article summarizes its findings and theories.

•

A FRIEND who has spent much time in Rocky Mountain mining camps believes that the writers of all the books and articles he has read on our great upland western region are guilty of a glaring omission. Because there is a limit to the amount of physical work men can do at high altitude, he contends that the latter has materially influenced the industrial progress of the area. He also holds that altitude h s a decided bearing on the general level of health, especially as regards newcomers—the difficulty of sleeping soundly being a major contributing factor. These matters, he states, are not even mentioned, much less discussed, in the historical and biographical literature of the West. The performance of both men and machinery is, in fact, definitely affected by altitude, and due allowance for a decrease in efficiency must be made when planning operations at considerable elevations. The article that starts on page 276 presents a general discussion of the problems encountered in conducting mining operations in a lofty section of Peru, with special reference to the use of compressed-air equipment. It includes notes on medical studies being undertaken there to determine the extent to which altitude influences the work and general bodily welfare of human beings.

•

TWO pages of pictures show natives of French West Africa using American-made drilling equipment in quarrying and mining operations. Pages 282-83.

•

ALL the advantages of stationary concrete-mixing plants have been incorporated in two floating plants developed by Dravo Corporation for river construction work. Air power contributes importantly to their operating efficiency. Page 284.

•

AN INGENIOUS machine that is actuated in part by pneumatic appliances has reduced the flame-hardening of metal surfaces to a more or less routine operation. Page 286.

Compressed Air Magazine

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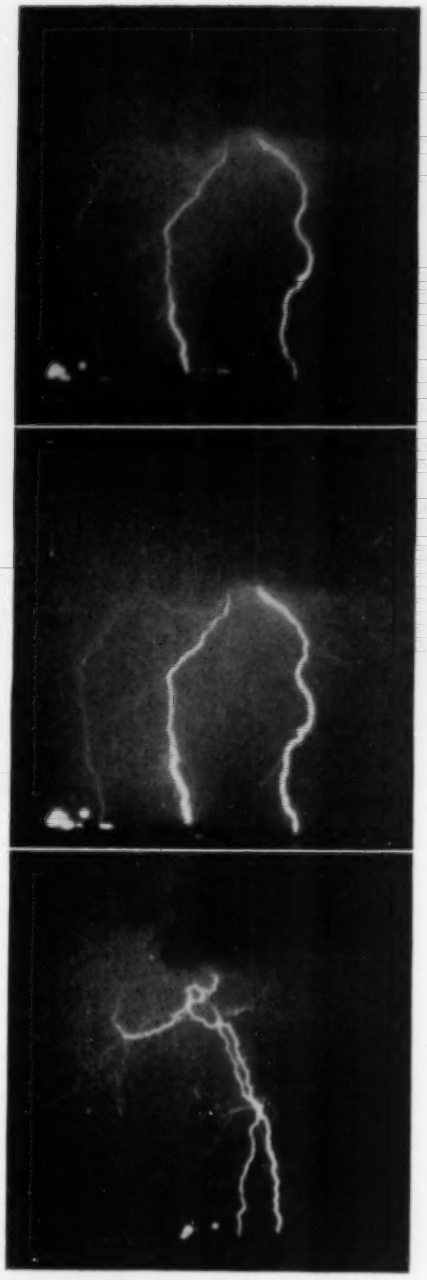
ACME PHOTO

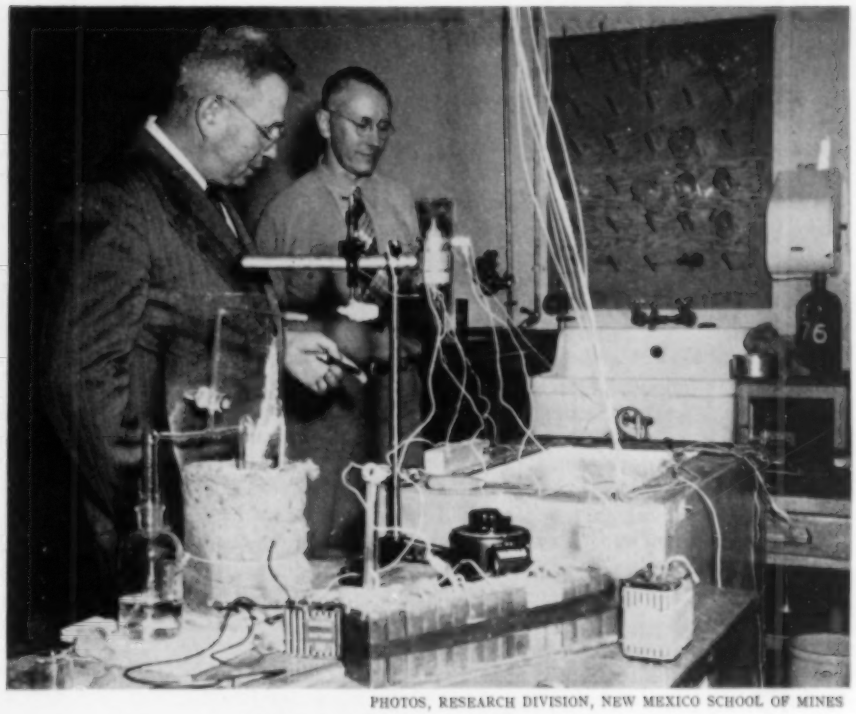
CONSTRUCTION MOUNTAINEERS

Suspended by safety lines, these drillers are putting blast holes in the steep rock face that will form the right abutment of Hungry Horse Dam on the south fork of the Flathead River in Montana. The structure is being built for the U. S. Bureau of Reclamation by the General Contracting Company, the Shea Company, and Morrison-Knudsen Company, Inc., as joint venturers under a $43,431,000 contract, second largest in the bureau's history. As originally planned, the dam would have been 520 feet high, giving it fifth place among the nation's loftiest concrete barriers. When the riverbed was excavated, however, it was found that the foundation would have to extend 45 feet lower than was at first figured in order to root it in sound rock. Under this revision, the structure will rise 565 feet above the lowest point and will rank third in height, being exceeded only by Hoover and Shasta. It will contain approximately three million cubic yards of concrete, a volume exceeded among dams only by Grand Coulee, Shasta, and Hoover. A power plant at the toe of the structure will house four 75,000-kva. generators each driven by a 105,000-hp. turbine. Storage of water behind the barrier is expected to begin in 1952.



MULTIPLE LIGHTNING STROKES

Photographs of lightning strokes occurring simultaneously or within an interval of one-tenth of a second, as recorded with a Bolex 16-mm. movie camera set on time exposure with a lens opening of F8. The research and development division of the New Mexico School of Mines has taken hundreds of these motion pictures in its study of the nature of lightning. They apparently prove, among other things, that sequential strokes follow more or less the same path, that the greatest electrical discharge is from earth to cloud, and that the discharges travel by spurts or surges rather than in a steady flow.



PHOTOS, RESEARCH DIVISION, NEW MEXICO SCHOOL OF MINES

THUNDERSTORM LABORATORY

Dr. E. J. Workman (left), president of the New Mexico School of Mines and director of its research and development division, is shown in the thunderstorm laboratory at Socorro with Dr. William D. Crozier, geophysicist.

Probing the Secret of Lightning

New Mexico Scientists Delving into Thunderstorm Phenomenon Find that Nature Operates a Stupendous Power Plant

Fremont Kutnewsky

EVERY time you see a thunderstorm you witness the generation of tremendous electrical energy. Where does it come from? How does nature do it? Benjamin Franklin made the first experiment with thunderstorm electricity in 1750. He flew a kite into a disturbed area and proved that lightning is electricity. There, for nearly 200 years, research stopped.

Then came aviation, depending on radio, radar, and electrical controls for safety. These devices had a way of going crazy in thunderstorms. Scientists began playing with the idea of creating rainstorms artificially, and long-range weather prediction became a possibility. All these developments tended to stimulate electrical-storm research.

Chasing thunderstorms is like trying to catch a bear, and a big one, by the tail. It means getting out in the rain and running for storm centers. You might get yourself electrocuted, but there's no substitute for personal, close-up observation. A single stroke of lightning carries enough power to operate all the lights and electrical appliances in your home for a year and a half. In a split second it discharges the equivalent of 3000 kw-hrs. of generated electricity. At any one time—while you are reading this—from 50,000 to 100,000 of these flashes are crackling around the earth's surface.

There has been much speculation as to how nature whips up all these electrical charges in thunderstorms. Possibly by friction between particles of dust or by ice crystals colliding in the air. They might be caused by the coalescing of water droplets in cloud formations. It was all more or less guesswork when Dr. E. J. Workman, now president of the New Mexico School of Mines, started thunderstorm research on a scientific basis at Albuquerque, N. Mex. His reports began to appear in the scientific press as early as 1936 and attracted widespread attention. He was asked to prepare the sections on thunderstorm mechanics for the 1948 edition of the Encyclopedia Britannica.

The high, dry Southwest proved ideal for the studies. Because thunderstorms often occur there in their simplest form, Doctor Workman and his associates were able to drive all around one and observe

it from every angle. They rigged up special photographic apparatus and, later, under contract with the U. S. Signal Corps, flew into storms in military aircraft manned by specially trained crews. They checked their observations by radar.

There is one thing about a thunderstorm that mere friction between random particles does not explain. The top and the bottom of a cloud hold opposite charges. Usually, the bottom is negatively charged while the top is positively charged. The first rumblings of a storm come from within the cloud, as the top and bottom charges begin to trade punches. Drag your feet across a carpet, then touch a metal doorknob. The spark you will see has been caused by a surplus of negative electrical charge generated by you through friction. But why has the top of the cloud a surplus of positive and the bottom a surplus of negative?

Electrical discharges are a neutralizing process whereby, under natural laws, collections of opposite charges seek interchange and balance. Tension is created when opposite charges are built up in areas adjacent to each other. These differences are called "potential." There is a breaking point at which potential differences must be reduced by give and take between positive- and negative-charge centers. The battery that starts your car is a contraption with opposite charge centers. When you step on the starter these charges exchange with each other by way of the starter motor. If you had a lightning rod 2 miles high there would be no lightning at that particular spot. Cloud and earth would exchange charges up and down the rod.

Of all the studies made so far, Doctor Workman's come nearer to explaining what takes place in a thunderstorm, and they have gone far enough to suggest new fields of research in power generation. In general, he states, such a storm occurs where there is a deep layer of warm, moist air which has nowhere to go but up. Any warm area on the earth's surface can start an upward movement of moisture-laden air. Forest fires frequently do it. They create the rainstorms that put out the fires often caused by lightning in the first place.

Warm air may get a start upward by a mountain slope. Sometimes all it takes is a collision between a mass of warm air and a "cold front." The cold air wedges itself underneath the warm air, forcing it up. Warm air always tends to rise, and as it does so it expands. The density of the air is measurably less for every foot of altitude. Temperature drops with altitude, so the ascending air cools progressively.

Layers of surrounding colder and heavier air press in on the warm air like a collar, forcing it farther upward. Finally, the warm air reaches a height where it is so cold that its moisture condenses into droplets. In the course of this process latent heat is released and gives the central air column another boost, with increasingly colder atmosphere continuing to press in from all sides. With further condensation into ice crystals, still more latent head is released and the column is forced higher. With this self-perpetuating, chimneylike updraft, the cloud may attain an altitude of 50,000 or 60,000 feet where its base will be well below the freezing point and its top will be 30° or more below freezing.

At the top of the cloud the updraft ends with a mushrooming outward. The ice crystals are heavy enough to begin falling. On their way down they collide with water droplets in the cloud. Here is where Doctor Workman has contributed something new to thunderstorm theory. A part of each droplet, he says, freezes on the incipient hailstone, giving it a slight negative charge of electricity. The remainder bounces off and is positively charged. There, in the floating droplets, is your positive-charge accumulation in the top of the cloud.

As they descend, the hailstones are built up in size and in negative electrical charge. Supercold, they start to melt when they get down into mere freezing temperatures near the bottom of the cloud. Now, through collisions, successive droplets drain off the negative charge from the hailstones, which go on down and often fall as rain. Thus we have hailstones dropping through space, accumulating negative charges at the expense of water droplets in the upper regions and losing the negative surplus at the bottom of the cloud. That's just where a concentration of negative potential causes lightning strokes.

Somehow, the earth is both negative and positive. You ground your radio to draw off a surplus charge so as to prevent static interference. Gasoline trucks drag a chain to release into the earth the excess charge built up in them by the turning of the wheels. As negative potential builds up in the base of the cloud, the earth rolls up a surplus of positive charge directly underneath it. Physicists say this happens by "induction." Let's say that opposites attract. These two charges reach for each other. Spurts of negative electricity extend downward from the cloud like "feelers" and come in contact with pointed extensions on the earth's surface which, by that time, are supercharged with an inviting positive load.

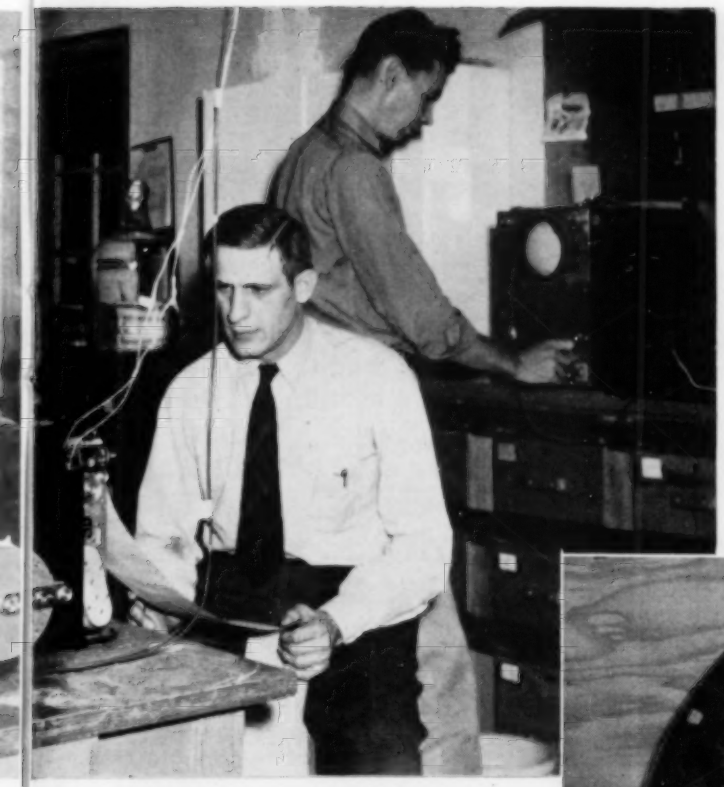
If you happen to be standing in the open in the path of a storm and feel a tingling in your body, you'd better, says Steve Reynolds, one of Doctor Workman's associates in the thunderstorm studies, dive inside your car. The earth is making an anode out of you. You're safe in your automobile, because static electrical charges never penetrate an area enclosed in metal. They accumulate on

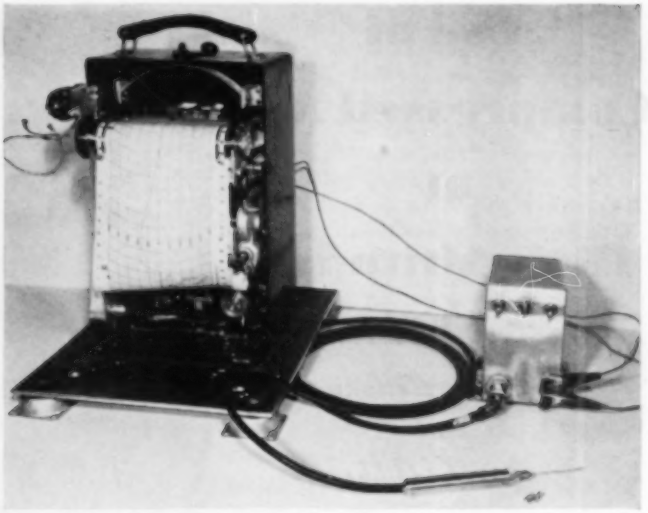
surfaces. When contact is made, come the flash and the thunder. Doctor Workman demonstrated with his photography that the major part of the lightning stroke is directed upward. Nothing is ever "struck" by lightning. Damage may be caused by a surge of electricity jumping from earth to cloud.

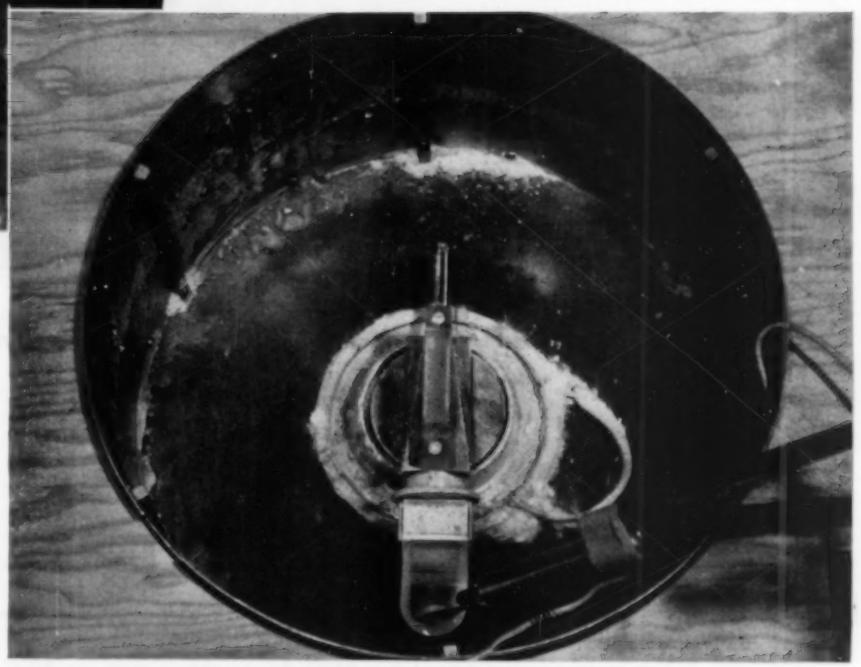
Once they conceived the theory of the bouncing raindrops, Doctor Workman and his helpers went to their laboratory and came out with much more than they bargained for. They proved that cold drops of water thrown against ice in a cold chamber left a negative charge and bounced off with a positive charge. But what amazed them was that the mere freezing of water created a sizable electrical charge all by itself!

They froze a sample of pure water in a small nickel-plated copper dish. The latter was grounded, and the surface of the water was connected to an electrical measuring device called an electrometer. As soon as a thin film of ice began to separate the water from the dish the instrument indicated a negative potential. Using contaminants in the water they were able, by freezing alone, to obtain as high as 235 volts! Most household lights are run on a 115-volt current, or less than half that amount. In a rainstorm, thousands of tons of water may be frozen and melted in an area of a few square miles.

Whether or not mere freezing of water may account for the tremendous potency of lightning, the Southwestern scientists have got their foot in the door that may lead to an understanding of one of na-





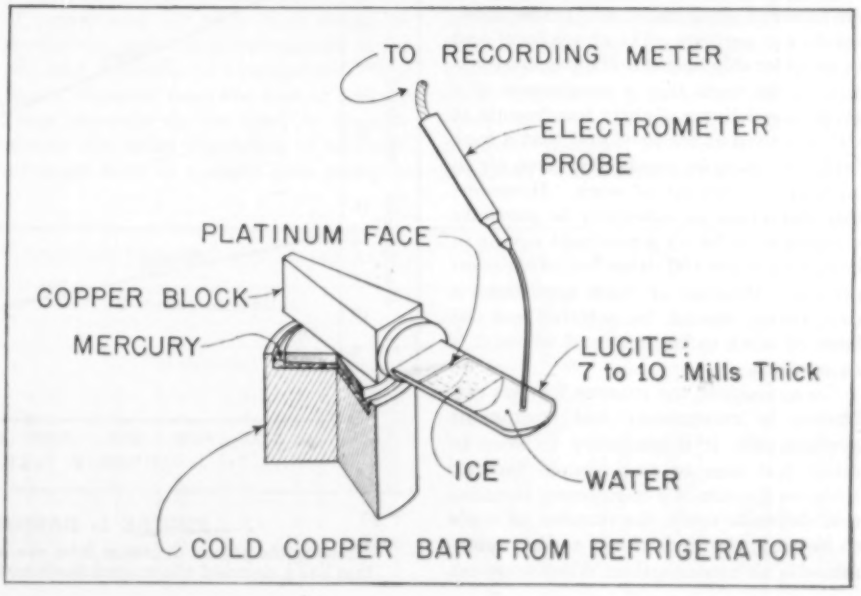


PRODUCING ELECTRICITY BY FREEZING WATER

Having evolved the theory that hailstones dropping through a moisture-laden cloud accumulate negative charges of electricity that are later released to form lightning strokes, the scientists verified it by laboratory tests. The sketch shows the apparatus in which pure water was frozen. Drops of cold water thrown against the ice left a negative charge and bounced off with a positive charge. Pictured at the right is the apparatus in place in a nickel-plated copper dish, with an electrometer probe in contact with the freezing compartment. The electrometer itself, which recorded the electrical potential, is illustrated at the top-right. Above is a scene in the laboratory during the experiments. From left to right the men are James H. Harrell, Jr., associate electrical engineer; Stephen E. Reynolds, project supervisor; and Max McWhirter, assistant mechanical engineer.

ture's great remaining secrets. Once man has the basic knowledge, he has a way of finding uses for natural processes. The manufacture of ice began about 80 years ago when it became known that rapid evaporation absorbs heat. Now it is considered feasible to freeze water not only for the purpose of creating cold but also to heat buildings with the heat that is released in the freezing process.

Doctor Workman and his associates do not think much of the idea of generating commercial quantities of electricity by freezing water; but, anyway, the fact has been established that nature does it.



Use of Compressed Air at High Altitudes

William Bellano
and
C. W. Gibbs

LOCATION MAP

The Volcan Mine, which is mainly discussed in this article, is near Ticlio, just east of Morococha, at an altitude of 16,000 feet.

TOPOGRAPHICAL MAP OF CENTRAL PERU

The mines mentioned in the accompanying article are located in the central and left sections of the area shown.

THE use of compressed air at high altitudes presents a number of problems that may be of interest to the general reader. Rating for rating, air-powered equipment and prime movers do not perform alike at sea level and at considerable heights. This is attributable to the facts that a compressor of a given size delivers slightly less free air at altitude than at sea level and that a rock drill, for example, needs more free air to do a given amount of work. However, this reduction in efficiency is partially compensated for by a resultant saving in horsepower per 100 cubic feet of air compressed. Because of these conditions a compressor should be selected on the basis of work to be done and where it is to operate.

To appreciate the reasons for this difference in compressor and equipment performance, it is necessary to keep in mind just one or two simple factors. Because the size of a compressor installation depends upon the number of tools to be used, the first thing to be determined is air consumption. When we speak of the air consumption of a rock drill, hoist, slusher, or any other piece of pneumatic equipment, we always refer to it as free air. Free air, in turn, denotes atmospheric air at the pressure and temperature normally existing at a specified elevation. Temperature can be disregarded for our purpose, but elevation is a pertinent factor.

The pressure of atmospheric air, or the barometric pressure, is actually the weight per unit area of the air above the reference point. If we say the barometric pressure at sea level is 14.7 psi.,

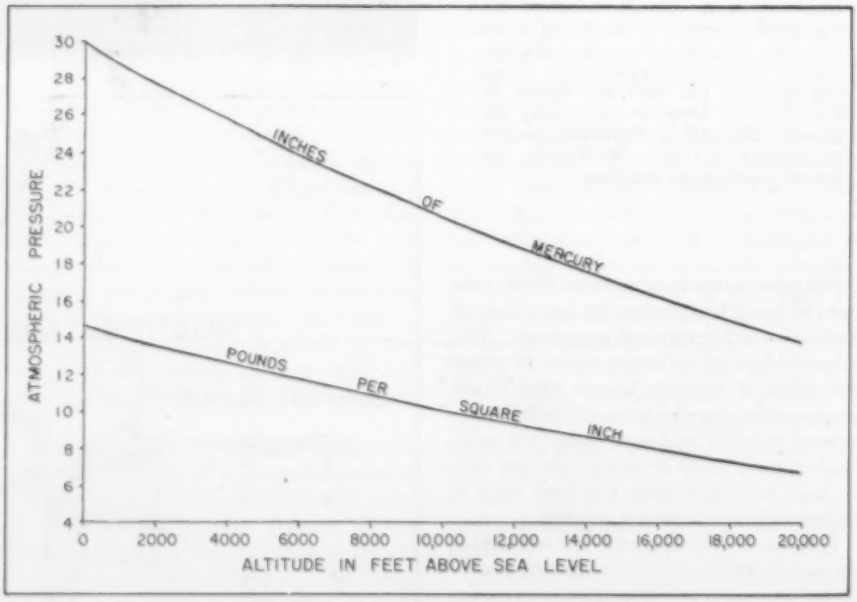


FIGURE 1- BAROMETRIC PRESSURES

Showing the rate of decrease from sea level to an altitude of 20,000 feet, a factor that has a decided effect upon the functioning of men and machines.

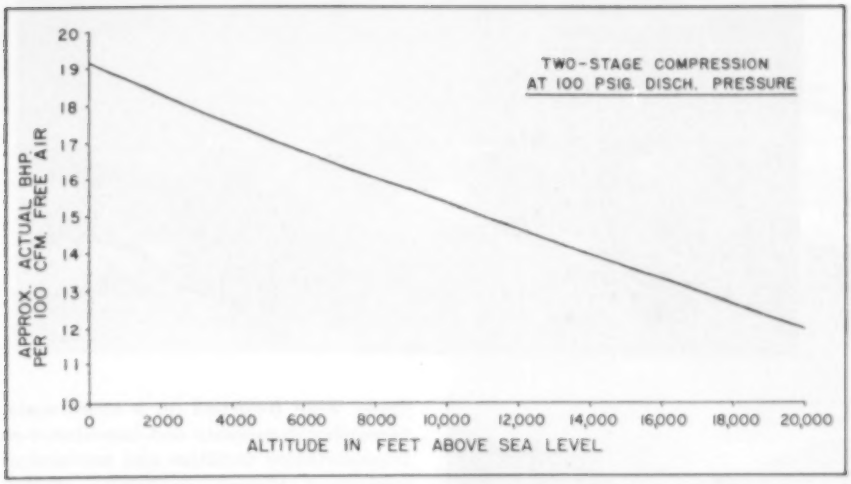


FIGURE 2- HORSEPOWER REQUIRED TO COMPRESS AIR

absolute, we mean that the column of air (1 square inch in cross section) from sea level to the top of the atmosphere surrounding the earth has an actual physical weight of 14.7 pounds. At any higher altitude, of course, the column is shorter and consequently weighs less. In other words, the barometric pressure is reduced. At an elevation of 60,000 feet, for instance, the overlying column of air weighs only about one pound per square inch. Conversely, in a mine extending a considerable distance below sea level the pressure of the air will be greater than 14.7 pounds.

This variation in atmospheric pressure is evident to anyone who has ridden in an elevator in a tall structure. The ears of most people are very sensitive to changes in pressure, and the rather uncomfortable sensation experienced with a rapid change in altitude, even in a building, is often counteracted by swallowing, which causes certain internal mechanical adjustments within the ear to balance the internal and external pressures. Figure 1 gives the barometric pressure for several altitudes up to 20,000 feet. Note that the pressure at the latter elevation is less than half that at sea level.

This reduction in atmospheric pressure, and therefore in density of the air and amount of contained oxygen, has a great deal to do with other than machines. People require oxygen to live, for life cannot be sustained unless there is enough in the air. Persons who grow up in high regions generally develop over-sized lungs (approximately 20 percent larger than normal), but even that does not necessarily enable them to carry on physically at the same rate as those dwelling at sea level. In other words, the relative efficiency of man as well as machines is impaired when working at appreciable altitudes. Anyone accustomed to conditions at or near sea level must exercise caution—avoid strenuous effort—at high altitudes, otherwise he might suffer great discomfort. On that account, life in such regions moves along at a relatively slow tempo.

In order to understand why an air-powered tool also "feels altitude," several points should be made clear. A tool of this kind is normally rated by the manufacturer on the basis of a given gauge pressure at the tool inlet, with air consumption expressed in cubic feet of free air at sea level. However, a pneumatic tool is fundamentally a rough type of air meter. It bites off a certain amount of compressed air with each stroke or revolution, uses the power packed in the air, and exhausts to atmosphere. The power obtained from the tool at a given *gauge* pressure at the inlet is approximately the same regardless of altitude, although there is a slight gain owing to the greater expansion ratio as elevation increases.

The volume of the dense air trapped in the tool cylinder also is the same at any elevation, but the quantity of *free* air required differs greatly. Suppose, for example, that a rock drill at sea level is supplied with air at 90 psi., gauge, and that its rated free-air consumption is 140 cfm. Ninety pounds gauge is 104.7 psi., absolute, at sea level where the atmospheric pressure is 14.7 psi., absolute. To convert 140 cfm. of free air into terms of dense air we multiply 140 by 14.7 and divide by 104.7. The answer is 19.7 cfm. of dense air.

If the same drill were operated at an elevation of 10,000 feet, where the barometric pressure is 10.1 psi., absolute, we would still use 19.7 cubic feet of dense air per minute but the free-air consumption would be 195 cfm. On a strictly theoretical basis, it would seem that the tool's requirement is increased by approximately 40 percent. At 15,000 feet, we would end up with a theoretical 52 percent increase in free-air consumption. There are actually other factors—including man-efficiency—that tend to reduce this multiplier, and over the years an empirical set of multipliers, shown in an accompanying table, has been developed that gives satisfactory results.

In the days when single-stage compressors were predominant and rated primarily at sea-level conditions, it was necessary to give real consideration to the reduction in capacity when those units were operated at high altitudes. But with modern 2-stage or compound machines, including the smaller sizes and also portable compressors of this design, it is not so necessary to take the decrease in capacity into account.

Briefly, the reason for the reduction in volumetric efficiency is that some air is trapped in the clearance space at the end of the compression stroke. This trapped air, when reëxpanded to intake pressure, reduces by just that much the amount of free air taken in by the compressor. The quantity of air thus trapped obviously depends upon the pressure or, rather, the compression ratio (absolute discharge pressure divided by absolute intake pressure), which increases with altitude.

MULTIPLIERS FOR AIR CONSUMPTION OF ROCK DRILLS AT VARIOUS ALTITUDES

Altitude Feet	Number of Drills																
	1	2	3	4	5	6	7	8	9	10	12	15	20	30	40	50	70
	Multiplier																
0	1.0	1.8	2.7	3.4	4.1	4.8	5.4	6.0	6.5	7.1	8.1	9.5	11.7	15.8	21.4	25.5	33.2
2000	1.1	1.9	2.9	3.6	4.4	5.1	5.8	6.4	7.0	7.6	8.7	10.2	12.5	16.9	22.9	27.3	35.5
4000	1.1	2.1	3.1	3.9	4.7	5.5	6.1	6.8	7.4	8.1	9.2	10.8	13.3	18.0	24.4	29.1	37.8
6000	1.2	2.2	3.2	4.1	4.9	5.8	6.5	7.2	7.8	8.5	9.7	11.4	14.0	19.0	25.7	30.6	39.8
8000	1.3	2.3	3.4	4.3	5.2	6.1	6.8	7.6	8.2	9.0	10.2	12.0	14.7	19.9	27.0	32.1	41.8
10000	1.3	2.4	3.6	4.5	5.4	6.3	7.1	7.9	8.6	9.4	10.7	12.5	15.4	20.9	28.3	33.7	43.8
12000	1.4	2.5	3.7	4.7	5.6	6.6	7.4	8.2	8.9	9.7	11.1	13.0	16.0	21.6	29.3	34.9	45.5
15000	1.4	2.6	3.9	4.9	5.9	6.9	7.7	8.6	9.3	10.2	11.6	13.6	16.7	22.6	30.6	36.5	47.5
20000	1.5	2.8	4.1	5.2	6.3	7.2	8.2	9.1	9.8	10.7	12.1	14.2	17.4	23.6	31.9	38.1	49.5

VOLCAN-MINE AREA

The lower camp of the mine, at Elevation 15,750, is shown below. The machine shop and compressor house are in the center of the picture and the mine offices at the left. At the right is a view of some of the surrounding higher region as it looks from the Volcan Level lying 16,500 feet above sea level.

This loss in capacity is apt to be serious in the case of a single-stage machine designed for normal 90 to 100 psi. discharge, but in a 2-stage unit, even at 15,000 feet, it will not amount to more than 8 to 10 percent. Two-stage compressors of special sizes engineered to meet high altitude conditions are available.

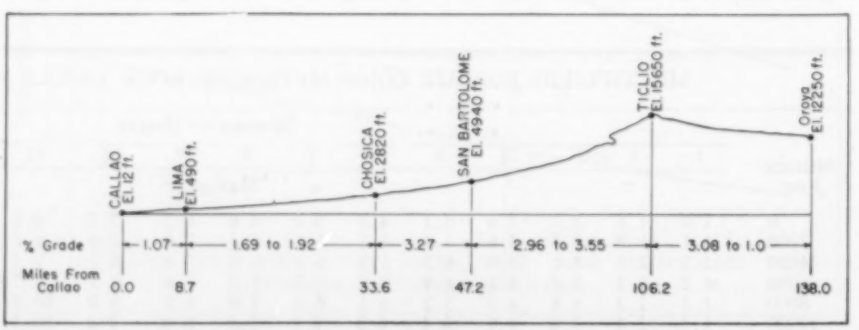
There is another factor in connection with compressors that deserves attention, and that is the effect of altitude on horsepower per unit of free air compressed. The energy required for a given machine will decrease considerably if the latter is installed above sea level. Figure 2 gives approximate horsepower figures at different elevations based on 100 cfm. actual free air compressed. Drivers, particularly electric motors and internal-combustion engines, deliver less than their sea-level rating at altitude. In making a selection for a compressor plant, it is therefore necessary to give full consideration to the elevations at which the drivers are to operate so that they can carry the load.

In Central Peru there are numerous operating mines located at altitudes ranging from 13,500 to more than 16,000 feet. These properties account for a large percentage of the country's nonferrous metal (copper, lead, and zinc) and gold-silver production. Many of them were first worked by the Spanish conquistadores for gold and silver only. Primitive methods were used to extract and treat the ores, the mines generally becoming unprofitable with depth because of water. During the last century many were reopened on a small scale, increasing in capacity and importance as transportation facilities and mechanical equipment became available. Today they are a considerable factor in Peru's economy and an important source of nonferrous metals for the United States.

The Volcan Mines Company has several properties in this region, the principal one being the Volcan Mine at Ticlio, 16,000 feet above sea level, where both the Central Railway of Peru and the central highway reach their highest point in the Andes. That property was operated intermittently for many years, mostly for gold and silver, until the pres-

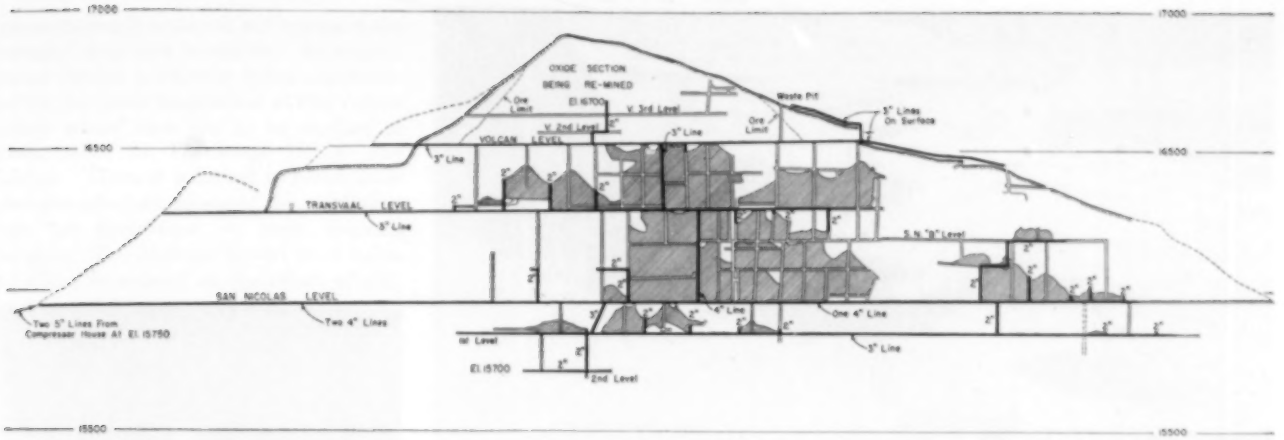
ELEVATIONS OF SOME OF PERU'S OPERATING MINES

Property	Feet
Cerro de Pasco Copper Corporation	
Cerro de Pasco	14,208
Morococha	14,850
San Cristobal	15,500
Julcani	13,600
Yauricocha	15,000
Casapalca	13,700
Goyllarisquisga (coal)	13,730
Volcan Mines Company	
Volcan (Ticlio)	16,000
San Florencio	15,800
Carahuacra	15,400
Other Mines	
Puquiococha	14,850
Huaron	15,090
Atacocha	14,000
Rio Pallanga	15,000
Colquijirca	14,000
Mina Ragra	15,600
Cercapuquio	14,500



PROFILE OF CENTRAL RAILWAY OF PERU

The rail line, as well as the central highway, reaches its highest point at Ticlio.



COMPRESSED-AIR DISTRIBUTION SYSTEM

Profile through the various working levels of the Volcan, with mined-out areas indicated by cross-hatching.

ent company was organized in 1943 with the aid of the United States Government. Since then it has produced more than 300 tons of zinc-lead ore daily by rill and flat-back cut-and-fill stoping, as well as some shrinkage stoping. In the upper levels, at altitudes ranging from 16,600 to more than 17,000 feet, old fills and sulphide ores containing soluble salts are being prepared for extensive exploitation and separate treatment.

All the ore mined is transported by the Central Railroad to the Mahr concentrator of the Cerro de Pasco Copper Corporation for beneficiation. Lead and copper concentrates are smelted at the Cerro de Pasco Oroya smelter, and the zinc concentrates are shipped either to the United States or Europe. In addition to the Volcan, the company operates the San Florencio Mine on lease (daily output 70 tons of zinc-lead ore) and the Carahuacra (100 tons of zinc-silver ore per day). The latter, once a great silver producer and recently acquired by the company, is in process of expansion to possibly 300 tons a day.

The plant of the Volcan Mine consists of machine shops; drill-repair and sharpening shops; blacksmith, car-repair, and carpenter shops; a sawmill, a compressor house, and the electrical department. Offices, warehouses, and workers' camps also are located there. The San Florencio and Carahuacra mines are equipped only with compressors and small blacksmith shops. All repair work is done at the Volcan plant. Electric power is bought at low cost and in adequate quantities for all requirements from the Cerro de Pasco Copper Corporation. Current is taken from the main 50,000-volt distributor, stepped down to 11,000 volts at the Volcan substation, and further reduced at the mine to 2300, 440, and 220 volts for local use.

Compressed air at the Volcan Mine is furnished by two machines having a combined capacity of 2600 cfm. at Elevation 15,000. An Ingersoll-Rand 2-stage unit, producing 1100 cfm. actual delivery, has been in service since 1944. A similar compressor was recently installed at the Carahuacra property, and a 650-cfm. machine has been in service at the San Florencio Mine since 1946.

The air-distribution system of the Volcan Mine is shown in a general profile view of the workings. The compressor house is located next to the railroad tracks at an elevation of approximately 15,750 feet, and the air is delivered through two 5-inch lines nearly 1800 feet long to a receiver at the mine portal or San Nicolas Level at an altitude of 16,000 feet. The main air feeders on the latter level are 4 inches in diameter and those on all other levels 3 inches, with a further reduction in pipe size to 2 inches in stopes and development headings. Air pressure in the working places is continually checked by the mine foreman with a needle gauge.

The number of rock drills, slusher hoists, and loading machines in operation at each property is listed in an accompanying table. Detachable steel bits are utilized exclusively. All drills are sent to the repair shop each month for inspection, but air hoists and loaders are examined regularly at the points of use by the mechanical department.

At the Volcan property, the principal mining method practiced is cut-and-fill stoping, either rill or flat-back, depending upon local wall conditions. Stopes are generally 165 feet long, with a fill raise dividing each into two wings. Cribbed manways and chutes serve throughout, the latter being lined with 2-inch planking to prevent rapid wear. Air and water lines are carried in the manway compartment and are kept close to the stope back. Manifolds distribute the air to the pneumatic equipment in the stopes.

Ingersoll-Rand stopers are in general use: R-48's in stopes and R-58's for raising and in hard ground. Both ore and waste fill in stopes are moved by double-drum air hoists pulling 38-inch scrapers. Wherever possible, mining is carried on "in balance"; that is, extraction proceeds in one wing while the other is "in fill." Waste fill is kept within 3 feet of the back to minimize sloughing of the hanging wall and is obtained from glory holes. That for the upper-level stopes comes from a surface talus slope connected to a lateral on the Volcan Level by short raises. The material for the lower levels is drawn from a glory hole (Elevation 16,700) serviced by a double-drum scraper hoist which slushes the waste into a transfer raise extending to the Transvaal Level. From there it is

COMPRESSED-AIR EQUIPMENT VOLCAN MINES COMPANY

Mine	Elevation Feet	Air Cfm.	Drills					
			R-48	R-58	JB-5	JB-50	DA-30	DA-35
Volcan Mine	16,000	2600	20	5	7	–	5	3
Tunnel*	15,400	550	–	–	–	–	–	4
San Florencio	15,800	650	5	–	3	–	3	–
Carahuacra	15,400	1100	1	–	3	4	–	–
		4900	26	5	13	4	8	7

	Air Hoists			
	Double-Drum	Single-Drum	Tuggers	Loaders
Volcan	9	5	3	2
San Florencio	2	1	–	–
Carahuacra	3	–	–	2
	14	6	3	4

*A 2-drill jumbo is used, the other two machines are standbys.

delivered by means of battery locomotives and 1-ton rocker dump cars to other transfer raises reaching the lower levels. Fill is relatively inexpensive mainly because of the slusher installations.

Horizontal development is accomplished by means of Ingersoll-Rand DA-30 and DA-35 drifters. Drifting is made easier in most cases by the use of single-machine jumbos. Three mechanical loaders are in service in the mine; all other headings are cleaned by hand. The amount of development work in progress at any one time depends entirely upon the man-power available, the greatest number of headings being driven between planting and harvest when labor is most plentiful. During that period, operating schedules are arranged so as to make maximum use of the compressed-air supply.

Of particular interest and importance is the remining of previously worked areas in the oxidized zones, which constitute the upper levels. Earlier operations above the Volcan Level were concentrated on the silver-gold bearing ores, the partially oxidized sulphide sections of the vein were either left in place or provided fill material. The whole area, from 16,600 to more than 17,000 feet above sea level, is now being prepared for large-scale exploitation. Solid blocks will be mined by the shrinkage or, if fill is available, by the cut-and-fill method. Other wide sections, where vein ore and filled places are common to one another, will be worked both by square-set and Mitchell slicing systems. A slusher drift has been cut at one point to transfer the remined fill to the ore pass. At present, most of the work is done with R-48 stopers and JB-5 Jackhamers. Machine performance at 17,000 feet compares favorably with that throughout the remainder of the mine.

PERFORMANCE RECORD AT VOLCAN MINES*

Average footage drilled per machine shift	30.0
Tons per man shift per underground worker	1.4
Tons per man shift in stopes	2.0
Tons per man shift all workers, underground and surface	0.6
Average monthly advance in a single-machine drift in feet—two shifts, hand mucking	50.0

*Based on two men operating each drifter, stoper, or Jackhamer.

Notes on the Effect of Altitude on Human Beings

SCIENTIFIC studies aimed at measuring man's capacity to work and live at high altitudes have been initiated in central Peru under the auspices of the Peruvian Government and Rockefeller Foundation. A medical institute, known as the Instituto Biologico y Patalogico Andina, has been established by them in Morococha (Elevation 14,850) for the general purpose of investigating the physiological make-up of the Andean native. Work of a preliminary nature has been carried on under the direction of doctors Hurtado and Miranda of the Rockefeller Foundation to determine the effect of altitude on the human body.

Studies have been limited to the respiratory system, heart action, corpuscle count, and the flow of the blood stream through the arteries when work is being performed. A treadmill and a bicycle have been used to aid in computing the work output of people indigenous to the Andean highlands, while actual measurements have been made by tapping the blood stream flowing to the heart.

WHEN WINTER COMES

Left, looking down on the San Nicolas Level camp site (Elevation 16,000) from the top of the Transvaal incline. Shown above is a battery locomotive running between banks of snow.

Preliminary results indicate that a man accustomed to that altitude can exert just as much physical effort, if not more, than a person native to the coastal region. As yet there is not enough evidence to prove whether this work could be sustained for an extended period, for a day, for instance. Apparently the physiological construction of the Andino is such that he obtains just as much oxygen fuel as his coastal brethren. His heart and lungs are approximately 20 percent larger, and the red-blood corpuscle count is also much greater.

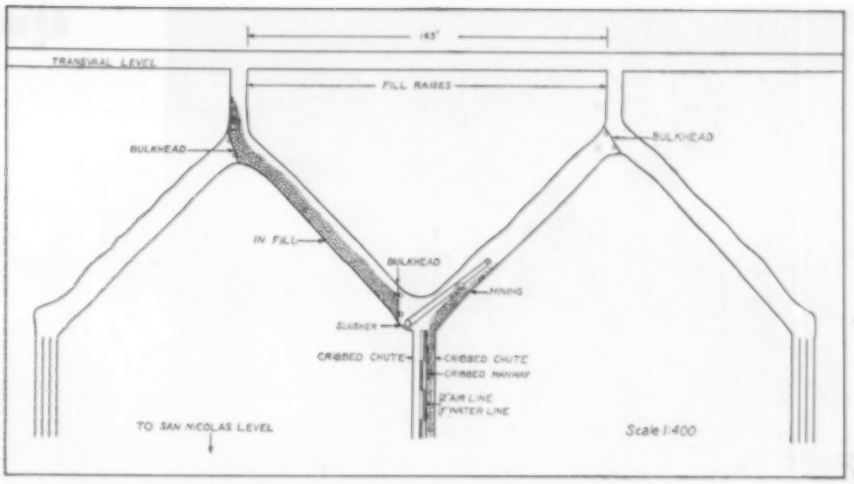
When the new hospital in the town of Morococha is completed for the institute

more thorough research will augment the meager data now available. An experiment station is likewise being constructed by the same foundation at the Volcan Mine where men are to be studied as they labor at Elevation 16,600 and higher. There it is hoped to reach some definite conclusions about the work that can be performed at such extreme heights. The findings should be of value to those interested in the effect of altitude on aviators.

Environment and living habits, as a matter of fact, have a greater bearing on the Andean's work output than altitude. Lack of proper diet; insufficient protection against cold, drinking of excessive amounts of *cana* and *pisco;* continual chewing of coca leaves combined with soda ash (cocaine is derived from coca, which numbs the nervous system, making a person insensible to cold and reducing the appetite); and easy prey to tuberculosis—all tend to lower the working capacity of the Peruvian laborer.

Habits of work that are the result of methods and machines used throughout the years, lack of mechanical aptitude, and absenteeism also are to be considered when comparing the performance of Andean labor with labor elsewhere in the world. Altitude is generally blamed for low production, whereas the other factors mentioned play just as important a part, a fact to which observers in other parts of Peru, and perhaps in South America generally, can bear witness.

Performance is improved wherever single- or 2-drill carriages are used in conjunction with loading machines.



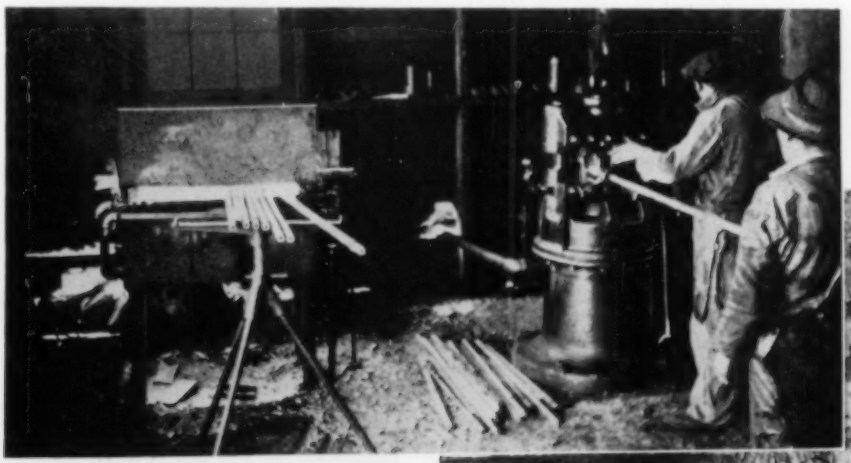
TYPICAL CUT-AND-FILL STOPE IN VOLCAN MINE

Slusher hoists also have increased output, but not to the same extent as in other mining regions. Maximum work is usually obtained with good supervision and organization on the part of management, whereas laxity or lack of adequate planning leads to low production and high costs. Just what can be done is borne out by a tunnel now being driven under closed contract for Volcan Mines. In a 2-machine heading, using a loader and operating on a 24-hour schedule, the daily advance is about 20 feet. Of course, more men and equipment are employed than there would be on a similar project in the United States.

High altitudes affect foreigners in a variety of ways. A new man who has never worked up in the Andes, or even an old-timer returning from a vacation on the coast, is often subjected to nausea, gas in the system, and throbbing headaches—all grouped under the local name of *soroche* (mountain sickness). This condition generally passes within a few days, with the exception of the gas, which may be a source of trouble as long as the person remains in the region. Cases that persist are classified as unfit for work.

Although an individual becomes acclimatized, he generally suffers from shortage of breath and frequently loses weight. Sleep is difficult for some, and others have no appetite. After a lapse of time, blood pressure drops below the point considered normal on the coast, and heart and lungs become enlarged to allow greater oxygen absorption. However, the incidence of heart trouble is probably no greater among employees foreign to high places than it is among those in any other region. Habits of work and living are determinants in cases of heart disease just as much as is altitude.

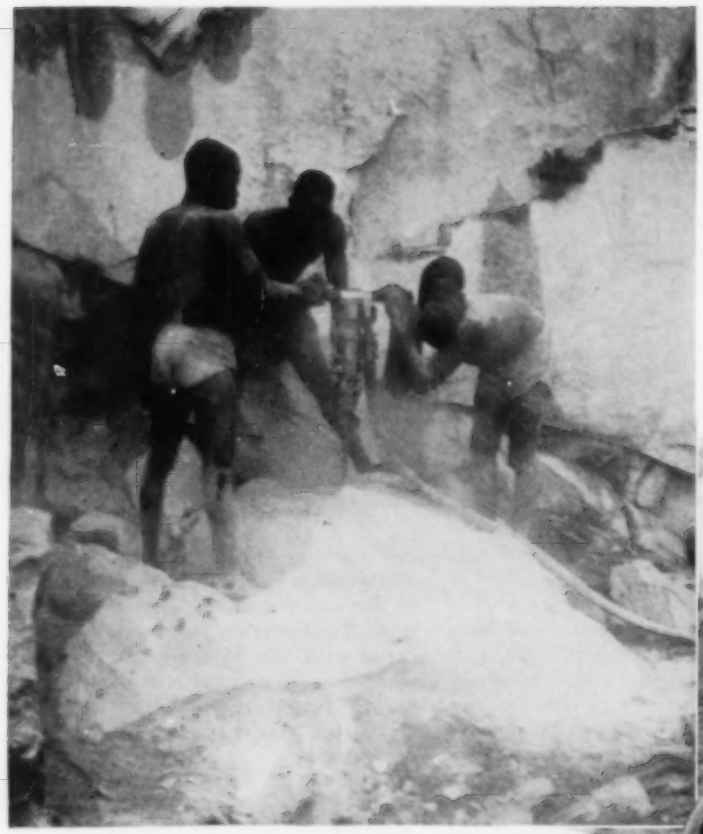
NOTE: Some of the information given in this appendix is relatively new, and so far there has not been enough scientific investigation to make positive statements.



MINING EQUIPMENT

An Ingersoll-Rand oil furnace and drill-steel sharpener are shown above reconditioning Jackrods in a shop at an altitude of 16,000 feet. Pictured at the right is a scraper powered by a slusher hoist (in building) moving waste rock in a glory hole above the Volcan Level.

Quarrying and Mining in



Natives running a Jackhamer in a quarry where stone is being extracted to build harbor works at Abidjan, an Ivory Coast port. Because of their small stature, three men were assigned to the drill, which would be operated by one in the United States.

MODERN rock-drilling equipment is so efficient that it has largely supplanted hand drilling even in regions where labor is plentiful and wages are relatively low. Although the work accomplished per man and per drill is greater on an average in highly industrialized nations, where familiarity with mechanical appliances is of long standing, worth-while savings over manual methods can, nevertheless, be effected with workers who have never seen a power tool.

This has been demonstrated for many years in South Africa, where natives recruited from farming areas are quickly converted into miners for the Transvaal gold properties. It is likewise true in other parts of the world. One underlying reason is that there is nothing complicated about running a rock drill, for a boy can do it if he has the strength to hold the machine. Moreover, a rock drill is so sturdily constructed and so positive and unfailing in its action that it rarely gets out of order or loses its full effectiveness. In short, it is essentially foolproof and tamperproof.

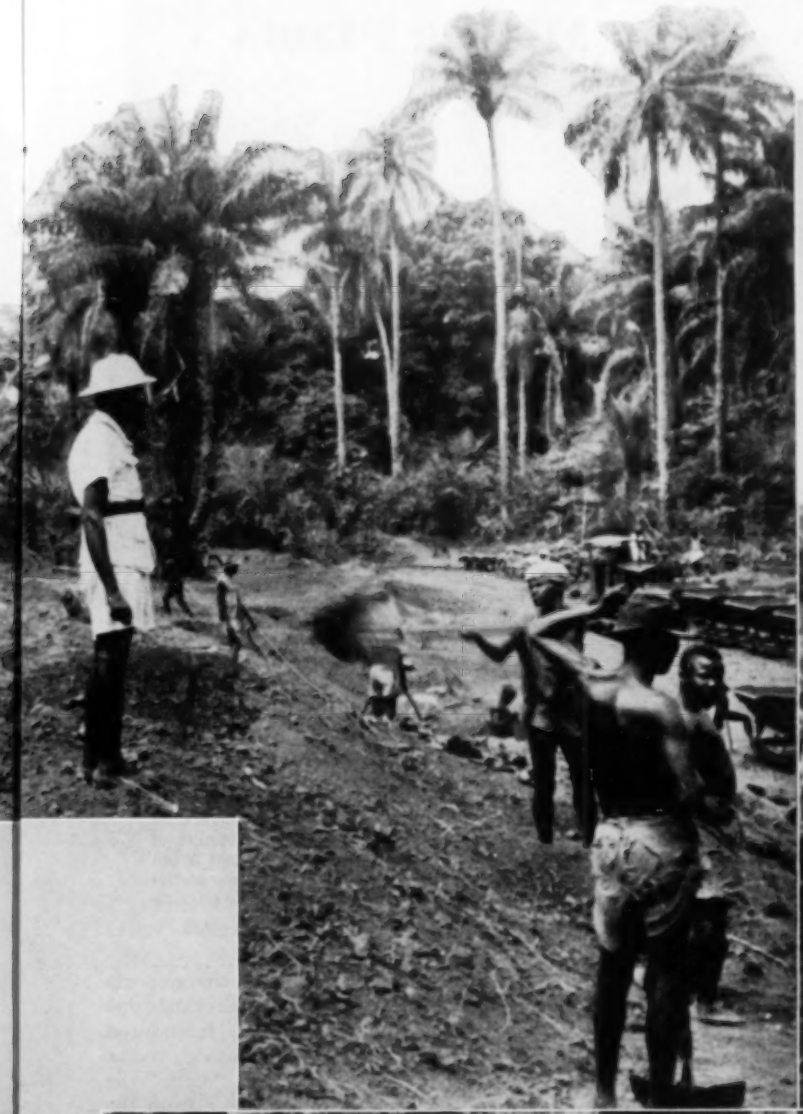
The accompanying pictures show natives in three sections of French West Africa manning rock drills and accessory equipment in quarrying and mining operations. Less than a century ago, slave traders were still actively exploiting the tribes of the region. Even today, white inhabitants represent but a tiny fraction of the 16,000,000 population. The vast expanse, which includes several colonies, has an area of 1,800,000 square miles and is eight times as large as France.

The country's economy is predominately agricultural. Rubber, palm oil, groundnuts, timber, and maize are the principal exports, with such fruits as bananas and pineapples becoming more and more important. The raising of cattle and sheep is also on the increase, and there is a considerable trade in hides. The region is so rich in natural resources that it may, as has been predicted, develop into a second Brazil. The climate, especially along the coast, is hot and humid and not overly inviting to the white man.

Mining of metals other than gold has made little progress in French West Africa, but the production of bauxite began some years ago. There are few engineering works, but harbor enlargement and modernization, because of the extent and growth of the country's exports and imports, has attained sizable proportions.

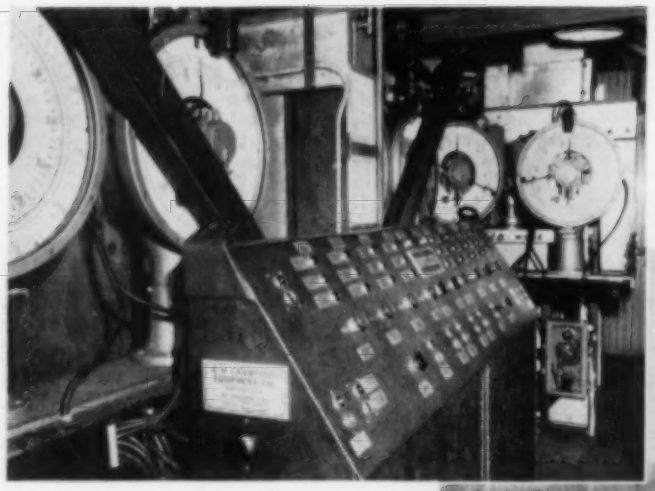
in French West Africa

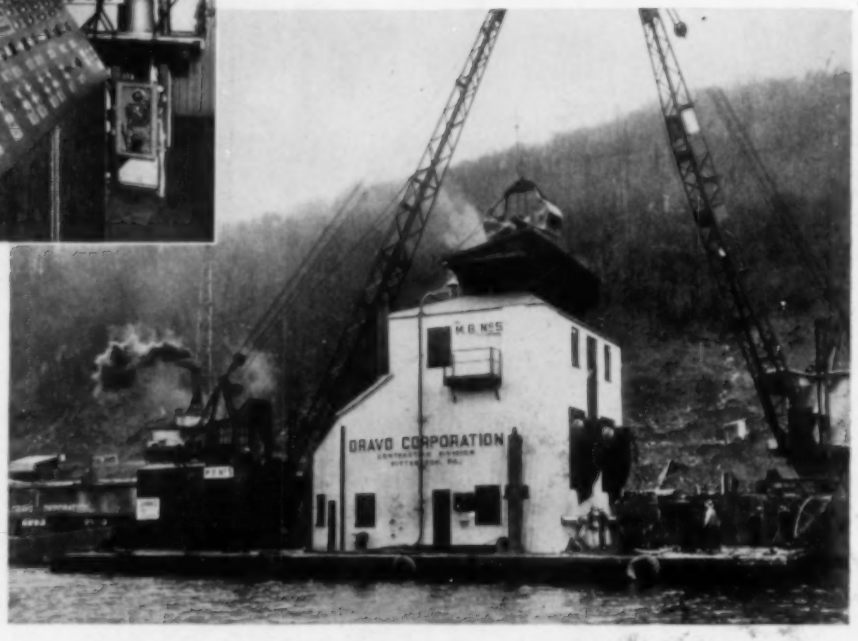
Natives opening up a bauxite mine among the palm trees near Tamara, French Guinea. At the left is a Canadian Ingersoll-Rand 210-cfm. portable compressor that supplies air for operating rock drills. The bauxite, which is the ore from which aluminum is obtained, is exported for reduction.



Quarrying syenite rock near Conakry, French Guinea, to be used in construction works in the harbor of that city, which is the principal port of the country. Two of the pictures show natives running an Ingersoll-Rand X-71 drifter drill on a wagon mounting. At the left is a view of the blacksmith shop where drill steel is reconditioned with the aid of an oil furnace (left) and a Leyner No. 34 air-operated sharpening machine.

Floating Concrete Mixing Plants





BOAT AND MIXER CONTROLS

The newly rebuilt Mixer Boat No. 5 is pictured above shortly after it was moved to the site of the lock and dam Dravo Corporation is erecting on the Monongahela River at Morgantown, W. Va. The two tilting-type mixing drums are projecting from the front of the superstructure. A concrete bucket handled by a dock-mounted revolving crane rests on the deck beneath the mixers. A clamshell bucket of aggregate obtained from the barge anchored at the stern of the mixer boat is being dumped by the latter's own crane into an overhead hopper. Shown at the upper-left are the control console and scales for automatically batching concrete ingredients and controlling the mixing cycle.

TWO water-borne concrete mixing plants now being used by the contracting division of Dravo Corporation are comparable in efficiency and operation with the most modern of land-based plants. Originally constructed as single-mixer units and converted several years later into double-mixer plants, both of the nontilting type, the barges were again remodeled when the division was awarded contracts by the U. S. Army Engineers for two major projects on the Monongahela River—a new lock and dam at Morgantown, W. Va., and a riverward lock chamber at Lock No. 2 at Braddock, Pa.

Specifications called for the use of tilting mixers for placing a considerable amount of concrete containing 3-inch or coarser aggregates in building large, unreinforced sections such as lock walls, etc. Accordingly, the mixer boats—Nos. 4 and 5—were converted to the tilting type at Dravo's shipyard and marine ways at Neville Island, Pittsburgh, Pa. The one described is No. 5, which is now being used at Morgantown. No. 4 is virtually identical.

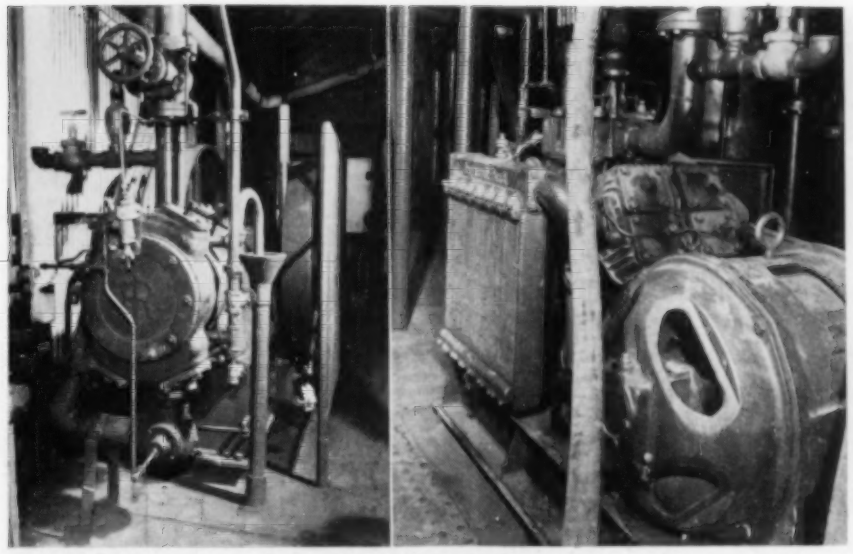
Dravo Corporation has found that floating mixing plants possess many advantages over those based on land in constructing projects along river banks, harbors, and other waterways. All that is required to move them from one job to another is to disconnect shore power and water lines and to summon a towboat or tug. While on a job they can be shifted to avoid transferring concrete, and they can operate regardless of fluctuations in water level. In addition to mixing and placing concrete, the Dravo barges are equipped with derricks and have steam connections for pile driving and miscellaneous other marine and coastal work.

The first step in remodeling Boat No. 5 was to dismantle and remove the mixing plant. Next, the steel hull was lengthened 10 feet for greater stability and strengthened with additional reinforcing to support the new plant, which is built of structural steel with aluminum sides. It is laid out on three operating levels connected by a spiral staircase. An annex houses the boilers.

A 4-compartment hopper for aggregates of different grades projects above the roof of the mixing plant. Mounted on the afterdeck is a steam-driven revolving crane with a 90-foot boom and a 2-cubic-yard clamshell bucket that either picks up the material from supply barges anchored alongside and dumps it into the hopper or handles concrete. When the mixers are producing their combined capacity of 80 cubic yards an hour for a prolonged period, the crane is used exclusively for transferring aggregates at the rate of 135 tons an hour, while an attendant derrick boat or dock-mounted revolving crane places concrete. During less active intervals the mixing-barge crane performs both functions.

Bulk cement, taken from a covered wood-lined barge moored alongside the mixer boat, is blown by compressed air through a 4-inch pipe to the plant's cement bin, a 500-cubic-foot container lined with tongue-and-groove maple flooring. At the bottom, the lining slopes downward toward discharge ports under which are mounted vane-type feeders. Compressed air, introduced periodically into the bin through banks of jets in the lower corners, "fluffs" the cement to insure its free flow from the bin. Water for mixing concrete is piped to the plant from shore because river water usually does not meet required standards of purity. However, for occasions when the boat is working in waters of acceptable quality, there are pumps on board to supply all needs.

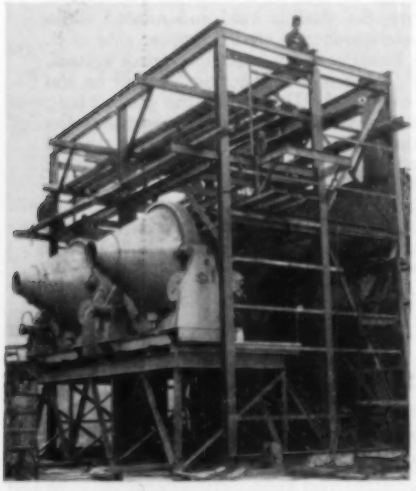
All functions involved in mixing concrete are regulated by push buttons grouped on a panel in the central control room. When the message "Ready to Batch" appears on the panel, the operator presses a button to start weighing simultaneously but separately all six materials—four grades of aggregate, cement, and water. Each of the aggregates flows by gravity from its storage bin into a chamber fitted with an individual 24-inch-diameter springless scale. When the correct quantity is in the batcher, a photoelectric cell mounted on the dial of the scale reverses the pres-



AIR COMPRESSORS

Compressed air for conveying cement, handling materials, operating maintenance tools, etc., is supplied by the two machines pictured here. The one at the right is a 2-stage, V-belt-driven I-R Type 40 with a capacity of 360 cfm. It supplies air for the batching controls and cement-conveying system. The other unit, a Class ER-1 horizontal, belt-driven, single-stage machine with a capacity of 300 cfm., furnishes power for operating the remainder of the pneumatic equipment on board.

sure in a pneumatic cylinder attached to the bin discharge gate, instantaneously shutting off the flow. Cement is delivered to a similar batcher by an electrically driven screw conveyor that takes the material from the vane feeders of the storage bin. Water flows by gravity from a supply tank to a batcher through a valve operated by an air cylinder. As soon as all the materials have been weighed out, a "Batch Complete" sign lights up on the panel. Interlocking controls on each gate prevent any chamber from discharging until all six scales indicate the predetermined weights.



TILTING-TYPE MIXERS

View during the reconstruction of the boats, showing two Smith 2-cubic-yard tilting-type concrete mixers that replaced nontilting units. The new mixers had to be set higher than the old ones, which involved revamping the equipment above the mixer level so as not to exceed the clearance of river bridges.

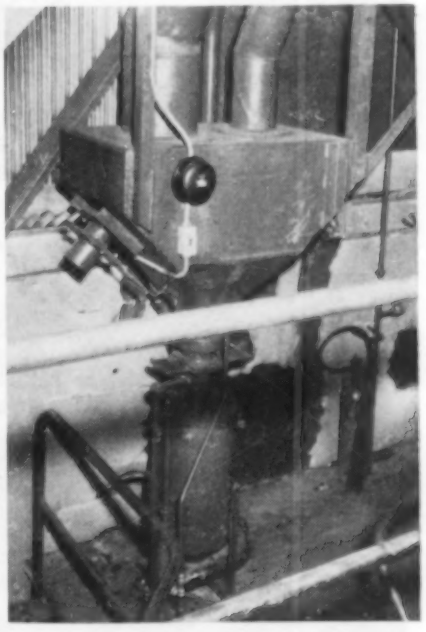
Movement of aggregates and cement to mixers is accomplished by a Dravo endless-type, 4-ply, rubber-covered conveyor belt, 36 inches wide, mounted in a horizontal position directly underneath the gates of the batchers. Rubber-lagged pulleys, 18 inches in diameter and spaced 11 feet apart, drive the belt in either direction at a speed of 4.2 feet a second.

After a glance at the control panel, where a white light indicates which of the two mixers at opposing ends of the belt is ready to receive the charge, the attendant presses a second button to start an interlocked sequence of operations. The discharge gates of the cement and aggregate batchers open, dropping the material onto the conveyor, which carries it in the right direction. At the end of its travel, it dumps the material by way of a small feed hopper and chute into the rotating mixer, into which water begins to flow. But before all the aggregates enter the hopper, the cement batcher is completely emptied by means of an automatic vibrator attached to it. Gates remain open until the scales are in balance, this condition being indicated by a "Batch Discharged" signal appearing on the control panel. The operator then presses a third button that stops the belt and closes all six gates.

During the 2-minute mixing period a green light glows on the panel. The push button which controls the tilting and righting of the drum is ineffective during this interval, but if pressed will cause the mixer to tilt automatically at the end of the period provided the concrete bucket is in place ready to receive the charge. After the drum has dumped its load and returned to the mixing position, the white light reappears on the panel to indicate completion of the cycle and readiness to begin over again. While one drum is mixing its charge, the batchers and materials-handling system are busy preparing one for the other drum. Under normal conditions, the plant produces a 2-cubic-yard batch of concrete every 90 seconds, a 17-percent increase over its preconversion performance.

In addition to the push buttons mentioned, the control panel has cutouts to eliminate any grade of aggregate from the mix to comply with specifications. Emergency batching buttons for each kind of aggregate are provided, as are emergency cement-vibrator buttons. Electrical recorders automatically keep account of cement consumption.

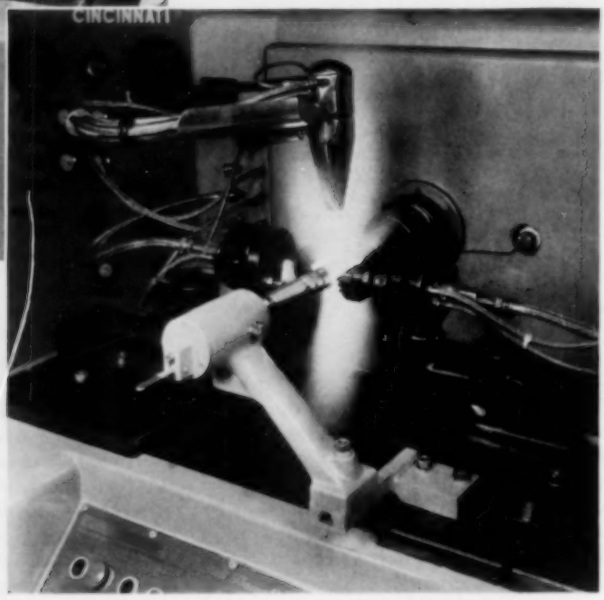
Modernization of Mixer Boat No. 5 created a demand for more compressed air than had formerly been required. This necessitated the installation of two machines, both of Ingersoll-Rand make, each of which is equipped with a 75-cubic-foot receiver. These units supply air primarily for the cement-conveying system and for sixteen pneumatic cylinders (fourteen control the batching gates and two tilt the mixing drums) but also for rock drills, tools for maintenance work, and, on occasions, for salvage and jetting operations.



SAVING CEMENT DUST

The storage bin that receives the air-conveyed cement is vented with an 8-inch-diameter opening fitted with baffles that trap most of the escaping dust. The hopper shown here salvages the remainder. It has a 10-cubic-foot conical-bottomed trap that is vented to atmosphere through a 12-inch pipe. An alarm notifies the operator when the hopper becomes filled. The reclaimed cement is dumped by means of a manually controlled valve into a 3-cubic-foot tank immediately below the hopper. High-pressure air is then admitted to this chamber to force the material through a 3-inch pipe back to the bin.

New Machine Flame-hardens Metal Parts



TYPICAL FLAMATIC SETUP

The general view, top, shows a shaft being hardened. All controls are located on one panel in front of the attendant, who can set the machine for manual or automatic operation. In the close-up above, the shaft is held and rotated while flames play on it from heads mounted on either side of it. The "brain" of the Flamatic is an electric control system, the nerve center of which is a thermopile focused on the work from directly overhead. The instant the piece being hardened reaches the predetermined temperature, the flames are extinguished, the piece stops turning, and is deposited, by retraction of the spindle, in a quenching bath. By varying the holding fixtures and flame heads, a wide variety of shapes can be treated. One manufacturer of power shovels utilizes two machines to harden 50 different parts that range in weight from 1 to 50 pounds each. Where identical pieces are being treated, one Flamatic can handle up to 250 an hour.

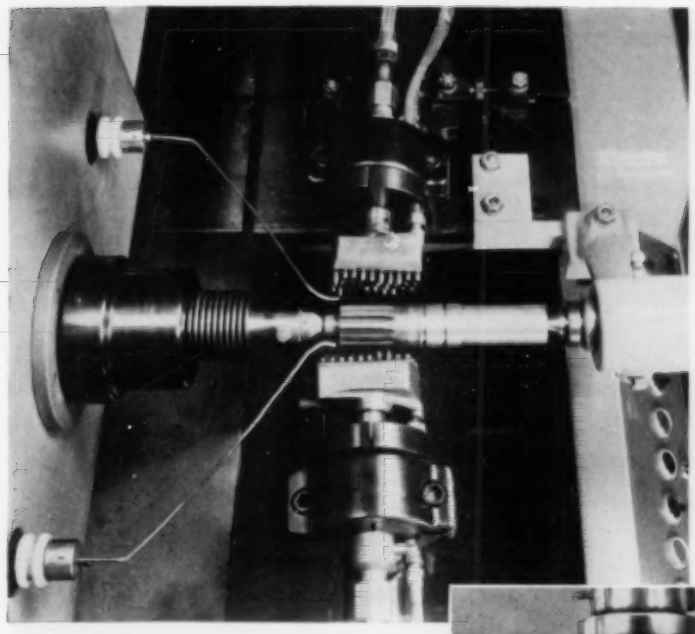
TYPICAL PIECES HARDENED

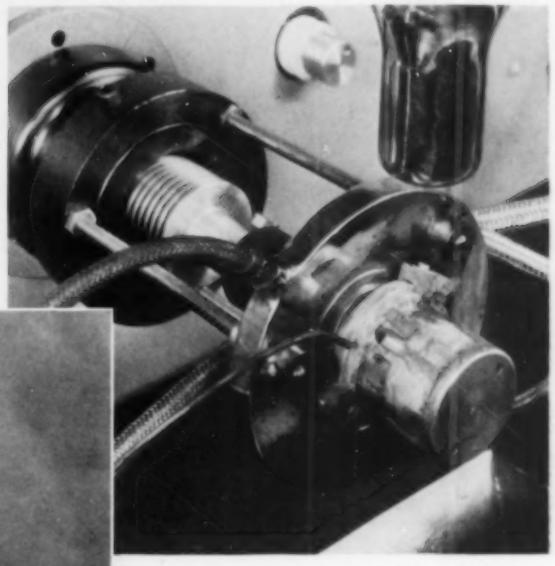
Using standard flame heads, short pieces such as gears and rings measuring up to 8 inches in diameter and 2 inches on the face can be accommodated. In general, the range includes parts of small diameters (shafts etc.) up to 18 inches long.

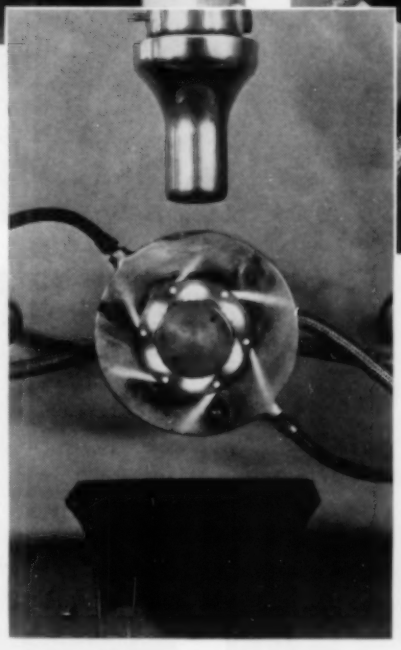
SURFACE hardening of selected areas of metal parts is made easy, it is claimed, by a new heat-treating machine developed by the Cincinnati Milling Machine Company. The Flamatic* combines the use of high-temperature oxyacetylene flames with electronic control of work-piece temperature and quick quenching in an oil bath. It can handle gears, shafts, barrel-type cams, pinions, and other parts that lend themselves to rotation during treatment in sizes up to 18 inches long when small in diameter and up to 8 inches in diameter of correspondingly shorter lengths. The hardening range is 800-1800°F. Push-button control and automatic operation give the machine high output as a production-line unit, and a variety of special flame heads and holding devices permits considerable flexibility in the size and shape of parts handled.

The electronic control consists of a sensitive thermopile which is focused on the object being treated. An electro-

*TRADEMARK







FLAME HEADS

Flame heads vary according to the shape and size of the parts being hardened and the nature of the heating. Illustrated at the left are opposed heads with multiple tips positioned so as to concentrate the heat on selected areas of a splined shaft. The view below shows a combination flame head and work-holding spindle used for treating six internal lobes of an automobile clutch ring. The flames issue from a series of six portholes, as pictured in the center of the page.

motive force generated in the thermopile by the radiant energy emanating from the work piece is transmitted to a temperature regulating and recording instrument, which controls the heating cycle. Although the action of the oxyacetylene flames is so rapid that the surface temperature of parts exposed to them can be raised 500°F. in one second, the accuracy of the control apparatus makes it possible to hold the final surface temperature of the work to within 5° of that desired. This accuracy can be maintained with each part put through the cycle, giving results much more uniform than those obtained by hand methods, which depend on visual observation to determine temperature.

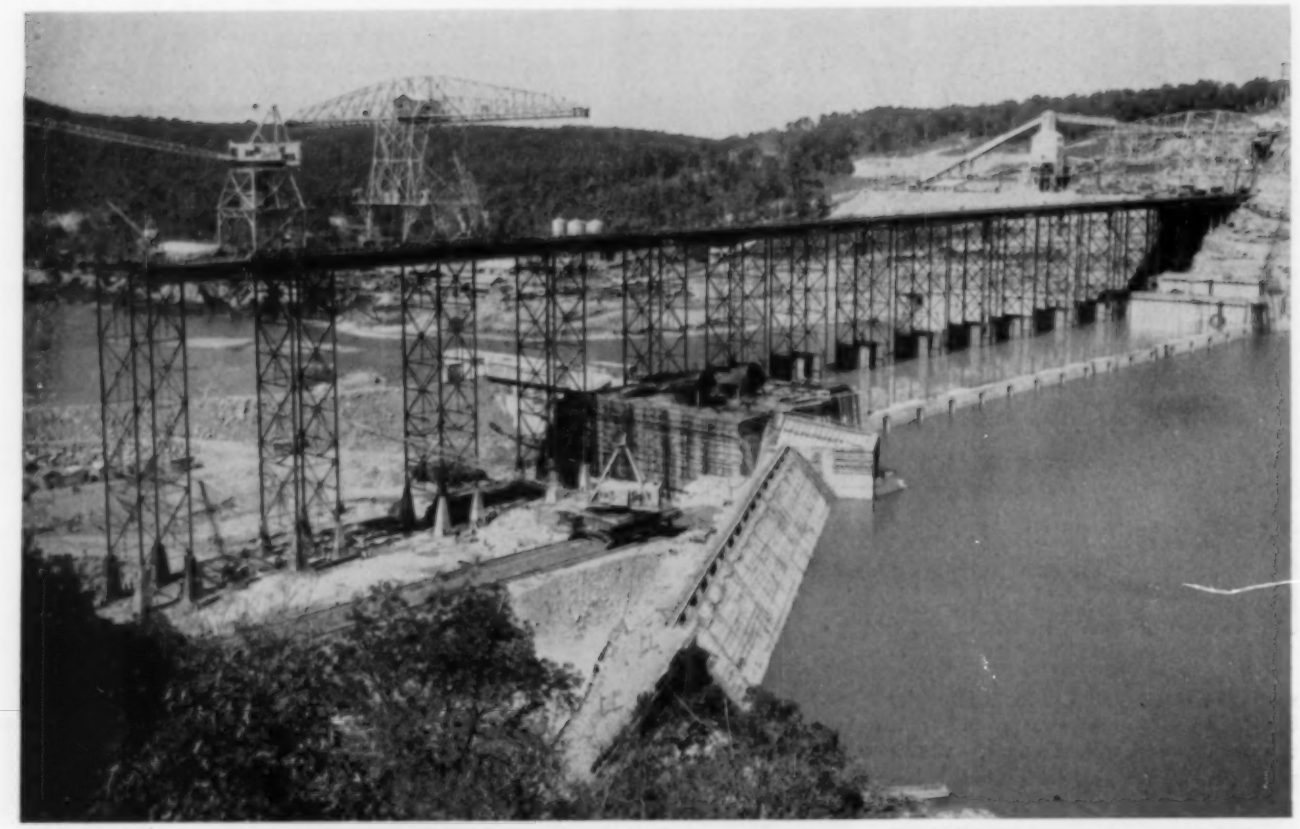
Work to be treated is positioned on a holding spindle and the "start" button on the control panel is pressed. As the spindle begins to rotate, a pair of live electrodes ignites the flame heads that heat the surface of the part. When the preset temperature is reached, the regulating instrument shuts off the flame heads and actuates a solenoid-operated air valve and cylinder that cause the spindle to retract and drop the work into the quenching medium. An endless wire-mesh conveyor extending into the bath delivers the piece to a take-off plate from which it may be transferred to another conveyor or otherwise removed. The entire heat-treating cycle takes from a few seconds to a few minutes, depending upon the size of the part and the depth of hardening.

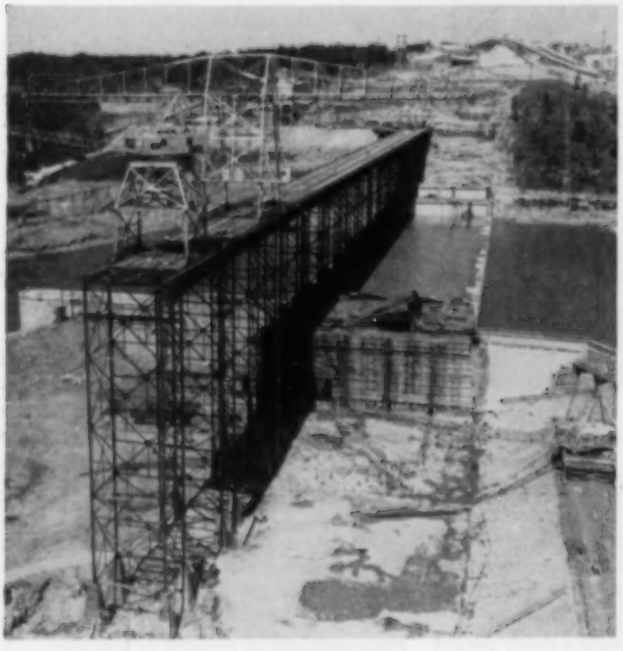
Push buttons that control all functions of the Flamatic are grouped on a panel located on the front of the machine and are interlocked to make sure that they are pressed in proper sequence. The unit can be set for either manual or automatic control. In the case of the former, the operator pushes a button to actuate the temperature-regulating apparatus, then a second button to start the spindle rotating, and finally a third one to turn on the flames. The remainder of the work is automatic. For completely automatic operation he merely presses the button which energizes the electronic control; the machine does the rest.

If the heated part needs a delay period before quenching, the Flamatic can be set so that the delay will occur automatically whether the machine is on manual or automatic control. Movement of the conveyor may be continuous, or the length of travel with each heating cycle can be varied from 0 to 60 inches; it may be automatic or it can be brought about at will by pushing the conveyor button. A thyratron unit, which controls the speed of the ¼-hp. motor driving the work-holding spindle, can be adjusted to turn the spindle from 0 to 400 times a minute.

Among the structural features of the machine are four pairs of valves that permit adjustment of the gas-flow rate to the individual flame heads. An automatic solenoid cut-off valve is also incorporated in each supply line ahead of the valve to shut off the flow in case of emergency. A wide variety of flame heads up to 18 inches long are obtainable to face-harden shafts and other parts of different sizes. For hardening several discontinuous surfaces simultaneously, there are special retracting flame heads that are actuated by pneumatic cylinders and timed in accordance with the operating cycle. They provide the flame heads with up to 5 inches of linear movement, which is adequate for most purposes.

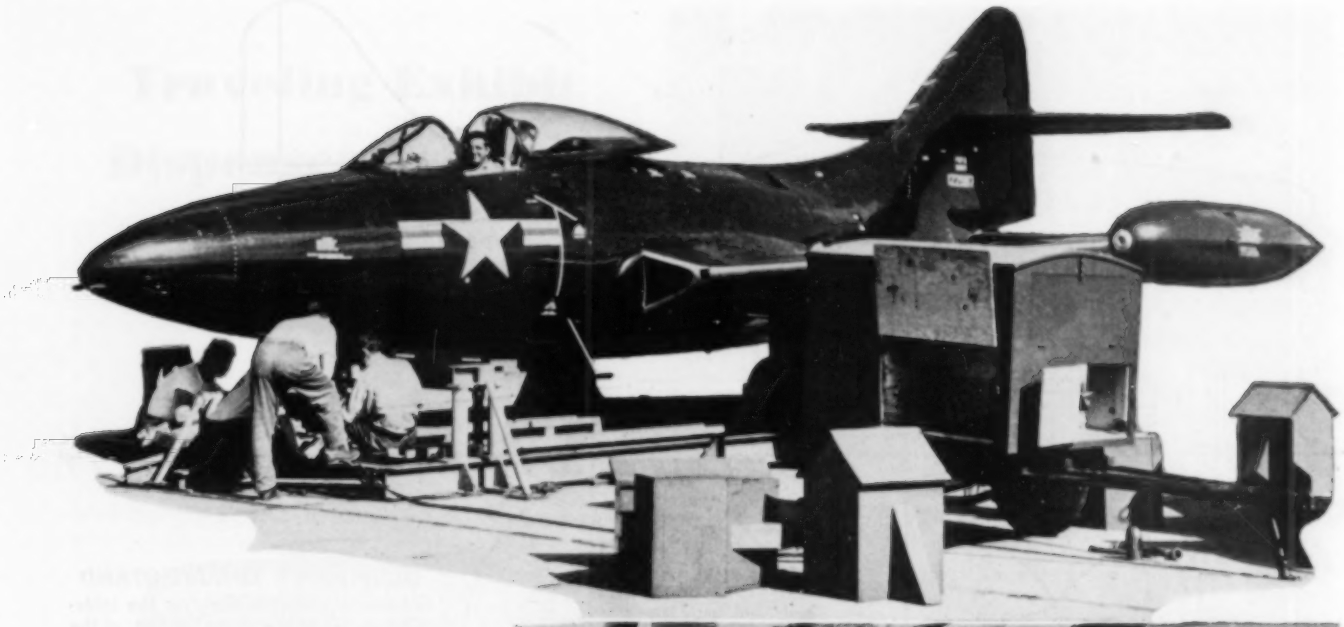
The Flamatic is 7 feet 8½ inches wide, 5 feet 5 inches deep, and 5 feet 6 inches high. It weighs 6500 pounds. A self-contained unit, it can be moved from place to place as desired or installed in a production line. Utilities required for its operation include 60-cycle, 3-phase, alternating current at either 220 or 440 volts; oxygen at a pressure of 30-50 psi.; acetylene or propane at 5-15 psi. pressure; water at a pressure of 60 psi.; and compressed air at approximately 40 psi. Because the flame heads are used only when a part is being heat-treated, gas consumption is at a minimum. Air consumption is in the neighborhood of 8 cfm. per heating cycle. The average performance, handling a variety of parts, is 150 cycles an hour.

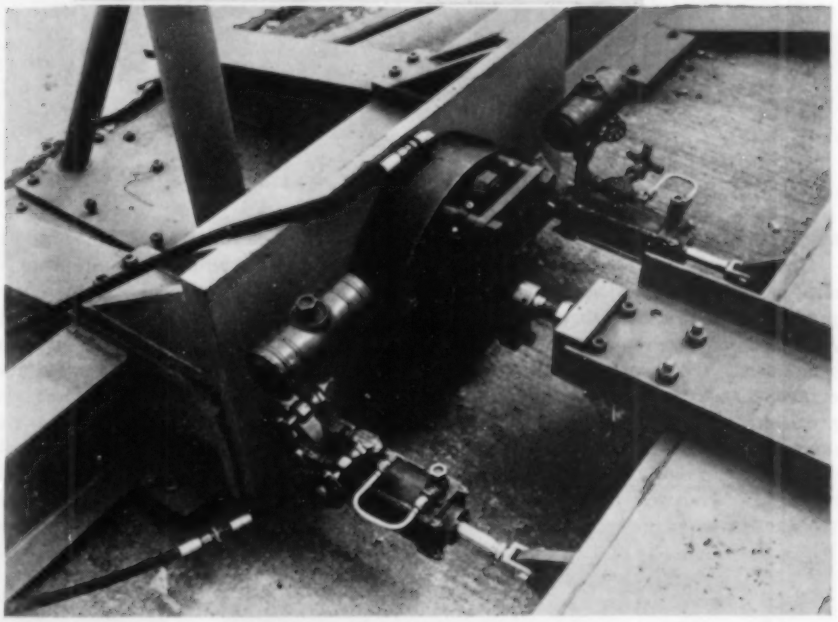




Progress at Bull Shoals Dam

These pictures show what has been done up to October 1 on the $76,000,000 structure being built across the White River in northern Arkansas by Ozark Dam Constructors for the Corps of Engineers, U. S. Army. Upon its completion next year, the dam will be 2256 feet long at the top and have a maximum height of 283 feet. Into its 2,100,000 cubic yards of concrete will go 1,800,000 barrels of cement, 3,700,000 tons of aggregates that are being produced from rock transported by belt conveyor from a quarry 7 miles away, and 3100 tons of reinforcing steel. The top view, taken looking downstream, shows the river flowing through sixteen flood-control conduits in the base of the 808-foot-long spillway section. This represents the second stage of diversion. During the initial excavation and concreting period, the stream flowed through the area at the left, while that at the right was enclosed in an 18-acre cofferdam. On top of the steel trestle are two Colby hammerhead cranes, with arms extending 146 feet up- and downstream, and an American revolving crane with a 125-foot boom. At the lower-left is a view along the axis of the dam. The other illustration shows excavating in progress inside the second-stage cofferdam for the foundation of the powerhouse section of the dam. In the center are being poured footings for addition bents of the steel trestle. Ozark Dam Constructors was organized by nine large contracting firms for the purpose of executing this big contract as coventurers. M. H. Slocum is directing the work as project superintendent.





Compressed Air Helps to Test Jet Planes

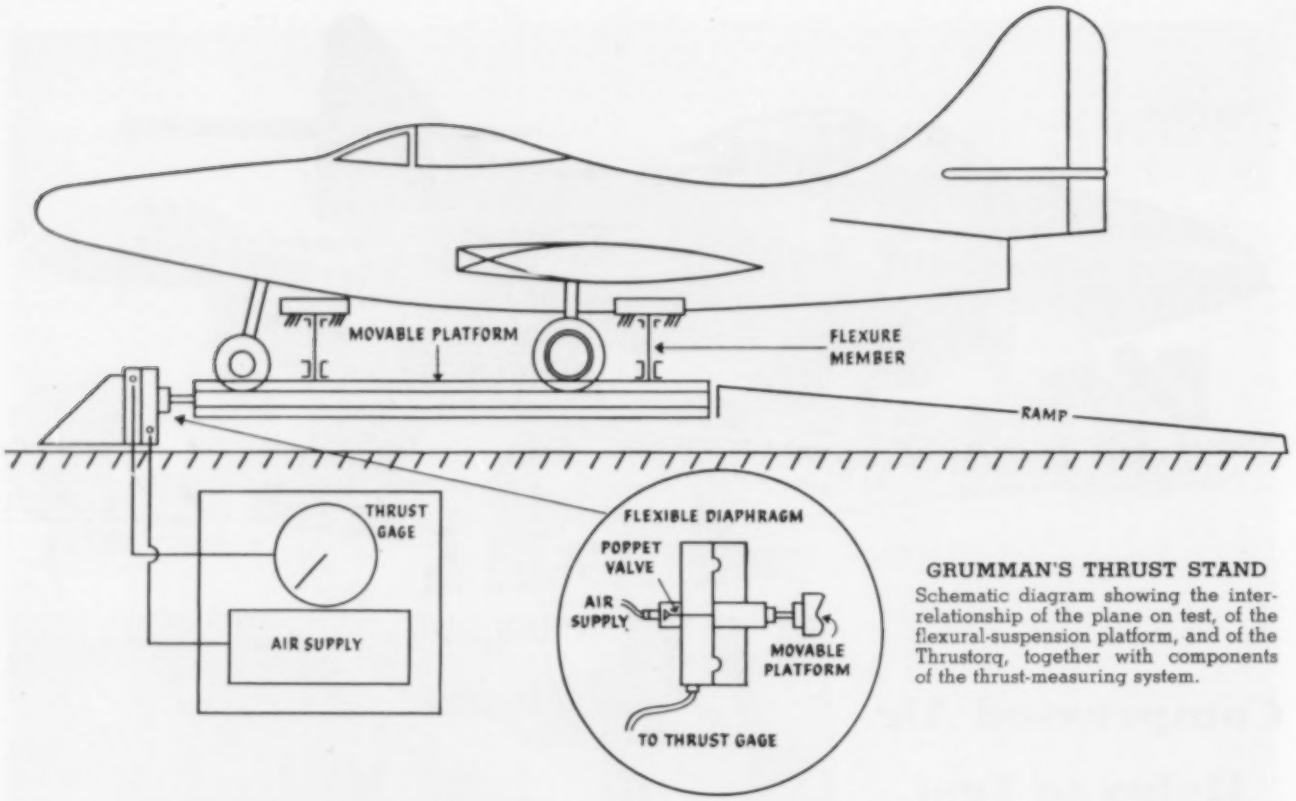
MEASURING the static thrust of an airplane as a unit, which differs from that of the engine alone, is done at the Bethpage, N. Y., plant of Grumman Aircraft Engineering Corporation by a unique test procedure developed by company engineers. There, production models of the Grumman "Panther"—a new carrier-based fighter equipped with one of the most powerful jet engines yet manufactured—are placed on a specially constructed movable platform and operated as if in full flight, a pneumatic force-measurement system absorbing the thrust of the craft and holding it motionless. By running the engine at various settings the engineers are able to plot curves showing the effective thrust of a plane as related to engine speed. Also, the procedure permits them to calibrate and check the operation of internal thrust-measuring instruments. Tail-pipe temperatures, engine rpm., duct-inlet static pressure, and other performance data are easily and precisely measured and recorded.

The main component of the system is the Thrustorq, a pneumatic force-balance meter or cell developed by Hagan Corporation for measuring either thrust (direct) force or torque (radial) force. The device embodies a nonmetallic flexible diaphragm one side of which takes the thrust of the plane through an adjustable bolt connecting the Thrustorq with the movable platform. Air pressure sufficient to balance the thrust is applied to the other side of the diaphragm, the air being automatically metered into the chamber by a sensitive poppet-type valve which is controlled by the diaphragm. The pressure needed to balance the thrust of the airplane is measured by a gauge which converts it into thrust readings.

A plane to be tested is moved by tractor and tow bar up a ramp onto the platform, where it is chocked firmly in position and the nose-wheel oleo strut is bled down to bring the thrust line within plus or minus 1° of horizontal. The platform with its load is then backed until the connecting bolt makes contact with the diaphragm. With air pressure on the meter, any "tare" or preload reading necessary to compensate for the effects of wind and temperature on the gauge readings is easily made. After

UNDERGOING TEST

Engineers are shown at the top positioning a Grumman "Panther" plane on the flexural-suspension platform in order to test it for thrust. The trailer parked near the tail of the plane contains a bottle of compressed air for actuating the force-balance cell, a reducing valve, a refillable dehydrator or drier, and a blowdown valve for exhausting the bottle when the test is completed or when the air pressure becomes too low for continued operation. In the lower picture is a close view of the Thrustorq firmly fastened to the mounting plate of the platform. An adjustable connecting bolt joins the diaphragm of the cell to the forward end of the movable section of the platform (lower right corner). Damping cylinders flank the force-balance cell to reduce lateral movement of the platform. The lower of the two hoses supplies air to the cell, while the upper one conveys cell air pressure to the precision gauge used to measure the plane's thrust.



GRUMMAN'S THRUST STAND

Schematic diagram showing the interrelationship of the plane on test, of the flexural-suspension platform, and of the Thrustorq, together with components of the thrust-measuring system.

that the bolt is locked firmly in place.

Once the set-up is completed, any desired power setting of the engine may be made and the resultant thrust measured. An electronic tachometer measures engine speeds, which normally range from 4000 to 12,000 rpm. in these tests. The precision-type gauge used to convert meter air pressure into thrust readings has an effective range of 0-110 psi. and is supplied with compressed air from a standard bottle equipped with a reducing valve, air filter, and drier. A standard needle valve serves as a blowdown valve when the system is exhausted and secured at the end of a run.

Among the advantages claimed for the Thrustorq are immunity from the effects of dust, dirt, and vibration, and that it can operate in any position. Simplicity of construction and absence of parts subjected to friction make the unit practically maintenance free. Although designed for measuring the thrust of jet planes, it is being used for continuous or intermittent weighing and for numerous other force-measurement purposes.

PHOTOS BY MARTIN N. RALPH

CARVING HEADSTONES WITH AIR POWER

Compressed air not only serves man in numerous ways throughout his lifetime but frequently also carves the headstone that marks his final resting place. These pictures illustrate two methods of inscribing stone that are replacing the traditional maul-and-chisel technique. At the left, Hugo Melen of Rutland, Vt., is lettering a granite monument with an air-operated cutting tool. The other view shows his son performing a similar job with a portable sandblasting outfit. Both pieces of equipment are transported in a truck that also carries a compressor to furnish the air.

Traveling Exhibit Dispenses Cylinder Knowledge

ON THE ROAD

Exterior and interior views of the trailer. Because of the weight of the vehicle and its equipment, a special hitch was designed for towing it. Two of the company's hydraulic cylinders, one on each side of the hitch, prevent the heavy trailer from swaying sidewise while it is being hauled over the highways. The interior shows the exhibition space with some of the cylinders, gauges, etc., operated by compressed air supplied by a motor-driven machine in the trailer.

BAND leader Kay Kyser with his radio program "College of Musical Knowledge" has nothing on The Miller Motor Company. The latter, a Chicago, Ill., firm, has gone the musical professor one better by building and outfitting a traveling "College of Cylinder Knowledge" which goes directly to potential customers and gives them lessons in the construction and performance of its line of air and hydraulic cylinders.

The display is housed in a luxurious 33-foot-long trailer divided into two parts—an exhibition space in front and living quarters with all the comforts of home: bedroom, shower, toilet, refrigerator, cook stove, heating furnace, a thermostatically controlled air-circulating system, etc. Built-in gasoline engine-driven generators supply power for lights, an air compressor, a mobile telephone unit, and for the operation of the exhibits when electricity cannot be obtained from an outside source.

Customers and prospects are notified of the date of arrival of the mobile unit, which is driven from town to town right into each plant or parked close by. In the 18-foot exhibition space much of interest is shown to visitors. They can observe an air cylinder cycling in a transparent plastic container full of water to test it for leaks. They themselves can pump a standard Miller 2000-psi. hydraulic cylinder up to a pressure of 5000 psi., the actual plant test pressure, and then on to 10,000 psi. to prove its strength. By merely blowing into a hose connected to the port of a cylinder, and thus raising a 150-pound piston on which a 200-pound man is standing, they can determine that the cylinder's friction loss is low. They can watch an air cylinder cycling smoothly at a line pressure of only 1½ psi. and a high-pressure hydraulic cylinder at 2½ psi.

Included in the display is a booster unit in which a hydraulic ram pressure of 2000 psi. is obtained and maintained by means of an 80-psi. air-operated booster without the use of costly heat-generating pumps and hydraulic installations. Questions are invited and answers discussed. Before leaving, each guest signs the register as a "graduate" of the College of Cylinder Knowledge.

An important part of the course is the proper care and handling of air and hydraulic cylinders. It teaches plant operational and maintenance men how leakage, cylinder breakage, and damage to seals and other components can be materially reduced or prevented to lower upkeep costs and reduce down time of machines on which the cylinders are used. On tour since early this year, the Miller exhibit has played host to thousands of visitors. The company is contemplating building two additional roving "institutions of higher learning."

Unseen Traffic Cop

RADAR has turned traffic cop, and a very effective one, we are told. Being invisible, the speeding motorist is unaware that he is in a trap and is inescapably caught. The new traffic officer is the Electro-Matic Speed Meter which was developed by the Automatic Signal Division of Eastern Industries, Inc. It can be set up anywhere along a highway or mounted in a patrol car, together with a recording milliammeter, and measures the speed of a moving vehicle without physical contact with it.

When a car passes the meter, the radar beam emanating from it bounces back from the moving object and in so doing undergoes a change in frequency. This difference is detected and converted into an electric current, which is registered directly on a chart in miles per hour. Reading is instantaneous. The unseen traffic cop immediately transmits the information to a law-enforcement officer down the road who nabs the offender and shows him to just what extent he has exceeded the speed limit.

This and That

Lake Shore Shaft Down 7500 Feet

Number 4 shaft at Lake Shore Mines, gold producer in the Kirkland Lake District of Canada, is now the deepest mine opening in North America. It has reached a point 7500 feet vertically below the surface and will be carried to a depth of 8000 feet. A neighboring mine, Wright-Hargreaves, was the previous record holder with a depth of 7272 feet. Lake Shore is deepening its workings in conformity with a plan to draw a little ore at a time from a large number of working areas. This scheme has been found to overcome the tendency toward rock bursts that formerly constituted a hazard. In pursuance of the plan, the mine now has its producing veins opened up along a total length of almost 20,000 feet, the deepest present mining level being at 5700 feet. The hoist used for sinking the shaft has been transferred to the 7450-foot level, which will permit opening up the vein system down to that horizon. The objective is gradually to increase the tonnage mined, which is currently around 1200 tons daily. The mill can handle 2500 tons and production approximated that figure before the incidence of rock bursts enforced a diminished rate of mining.

* * *

Growing Use of Aluminum

Although aluminum is a relatively new metal in the commerical sense, its production in this country on a volume basis ranks second to that of iron and steel. As is true of most industrial metals, the supply of aluminum comes from both primary and secondary sources. Most of the primary metal is made by reducing aluminum oxide that is obtained from the mineral bauxite. It is used chiefly to turn out wrought mill products such as plate, sheet, strip, rod, bar, wire, and tubing. Secondary aluminum is made from scrap of two kinds—new scrap from the mills and old scrap collected in the form of discarded consumers' goods—and is produced in smelters. It usually includes about half of the 400,000 tons of new scrap that comes from the primary aluminum mills each year. Approximately 3000 foundries and die casters in the United States convert the secondary aluminum into castings of the sand, permanent-mold, and die types. According to the American Smelting & Refining Company, primary-aluminum production amounts to around 620,000 tons annually, as against 1,090,000 tons of copper, 790,000 tons of zinc, and 440,000 tons of lead. In volume, however, because of the metal's lightness, it approaches the total copper, zinc, and lead output. If the production from scrap metal is added in each case, aluminum exceeds the three other metals combined on a volume basis.

* * *

Leadville Article Stirs Memories

The following comments on the article *Leadville Through the Years*, by L. D. Anderson (C. A. M., April, 1949), come from Edward M. Lynch, former resident of "Cloud City" who now lives in Elko, Nev.

I lived in Leadville during all the 1890's and saw the town in boom and depression stages. My father superintended the installation of machinery in the Robert E. Lee Mine, which was managed by Estey. This was the mine's second attempt at becoming a producer, and quite successful it was, too. The Lee was not far from Tabor's Matchless, which I remember extremely well. A great uncle of mine, Baxter Stiles, twice mayor of Denver, lost his interest in the Chrysolite in a poker game.

The Coronado, one of the mines that built a fortress during the strike period with high-standing blockhouses a la Revolutionary War days, was one block from our house. It housed a lot of strikebreakers, and was attacked by the "Regulators" and burned, with much rifle firing and setting off of dynamite bombs. The Hibschle Mine was about 100 feet above our house, on the opposite side from the Coronado. There the men knelt like a line of infantry and fired volleys over our house at the Coronado Mine. Afterward, I and the kid next door picked up 147 cartridge shells in our backyard.

I made many trips to the Little Jonny Mine, driving four horses hitched to a grocery sleigh. During the winter it was often hard to see farther than the middle of the backs of the wheel team because of falling snow. There is a story in the hauling of ore from that mine before the railroad got through and the building in Leadville of the only wagons that could stand the work.

The snows of 1898 were so deep that the men at the mines had to help the railroads get going. Rotary plows could get the snow off the tracks, but there was so much ice alongside the rails that the flanges of the wheels would simply slide—no traction. I was working for Sam Nicholson, later governor and state senator, at the MAB Mine, and was one of his "snow birds" that put in three or four days digging ice from the rails so that as many as four locomotives could get a few mail and express cars up the Arkansas Valley and on over Tennessee Pass.

That winter the snow was 15 and 16 feet deep on the level and from 35 to 50 feet in drifts. And still they hauled ore from the Little Jonny in those magnificent 4-horse wagons. They came down the long hills with double rough-locks on the rear wheels, banking the front wheels against the inside of the icy ruts, the horses galloping. Well I remember the kind of men the drivers were, their wildness, the armorlike foot-wide canvas or leather belts that kept their abdomens from being frozen or jellied by the bouncing, and the wonderful "savy" of the horses.

The early use of air compressors is mentioned by Mr. Anderson. They were used for underground ventilation long before mechanical rock drills were generally adopted. I remember seeing them prior to 1895 and hearing the miners' stories of the "dangers of working in compressed air." Incidentally, rails were not laid to "all the mines" nearly so early as Mr. Anderson thinks.

Leadville had a drum corps, of which I was for nine years a member, that challenged the world. We had a silent drill of more than 150 movements, done entirely to whistle. The town sent the corps to every big doings everywhere, as much as $10,000 being raised for trips to Boston, Washington, and other distant points. It's a privilege to live in Colorado, and a God-given one to have lived in Leadville in those eventful days.

* * *

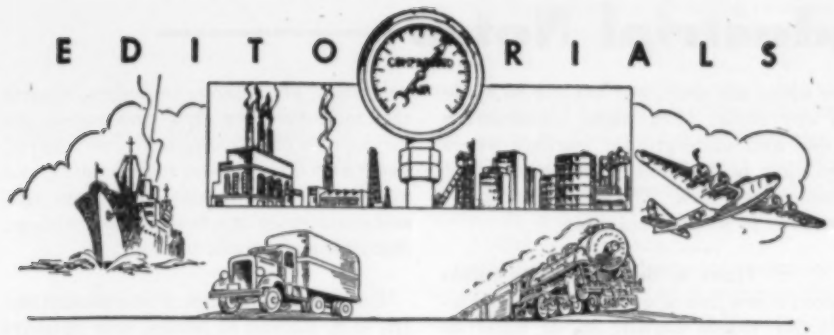
Rubber Pavement Tests

The idea of incorporating rubber in asphaltic mixes for street surfacing originated in Europe and has been tried out in a limited way in a few American midwestern cities under the sponsorship of rubber companies. Now New York City is conducting experiments in coöperation with the United States Rubber Company to determine how the compound will stand up under heavy traffic. Six stretches of pavement have been laid in Manhattan Borough, the proportion of rubber used in each case varying from 12 to 25 pounds per ton of paving mixture and averaging 1.75 percent by weight. All told, 3½ tons of natural rubber was included in the 200 tons of material laid. Among the advantages claimed for the rubber-containing pavement are resistance to cracking in winter and softening in summer. New York authorities propose to leave the test stretches in place for from 6 to 18 months before appraising their worth.

* * *

Tea for 2700

Because native South Africans—the principal labor force in the Transvaal gold mines—have embraced the British custom of drinking tea, the managements are faced with a prodigious task in brewing the beverage in the quantities required. In the past, tea was usually made in kitchen utensils that were also needed for other culinary purposes. This wasn't very satisfactory, so special tea-brewing apparatus is now coming into use. Equipment of this kind recently put in service in the native compound kitchen of the Vlakfontein Gold Mining Company consists of two tea brewers, of 50-gallon capacity each, that receive boiling water alternately from a 60-gallon steam-heated boiler. The kitchen provides 2700 natives with food cafeteria style in 90 minutes, which is at the rate of one every two seconds. With it, each man gets a cup of tea. The consumption of the beverage per meal totals 150 gallons.



RENAMING OF ELEMENTS

FEW words mean the same thing in all languages, and even different peoples who speak a common tongue don't always use the same terminology. For example, the American's gasoline is the Briton's petrol. Narrowing the distinction even more, a scup in New England is a porgy when it gets down around New York. Hundreds of similar variations might be ferreted out.

Much thought and effort have been expended in exploring the possibilities of creating a universal language, but so far the results have been negligible. Judging from the lack of unanimity among nations in the past few decades, it will be a long time before the powers get around to agreeing upon a common vehicle of thought expression.

Although statesmen, bankers, and merchants continue to carry on international relations with the aid of interpreters and translators, the scientists of the world are making some progress towards establishing a basis of general understanding among themselves. It is true that they haven't gone far as yet, but at least they are disposed to agree rather than disagree.

Men engaged in scientific research are frequently inclined to leap over international barriers that prove obstacles in other lines of endeavor. Great fundamental discoveries are as a rule quickly published and freely translated into many languages so that those elsewhere, who are working along similar or related lines, may use them as springboards to still greater achievements.

One of the requisites of this mutual assistance is basic terminology that will avoid confusion and lead to clarity of expression. Recognizing this, scientists the world over agree on specific words to designate specific physical objects or mental conceptions. An example is the authority conferred upon the International Union of Chemistry to adopt official international names for the elements of which the universe is made.

Exercising that power, the union recently standardized the names of six natural elements and gave official designations to several man-made elements that came into being as a result of atomic bomb technology. The union does not act arbitrarily; instead it endeavors to assign names on the basis of preponderance of usage. For instance, the metal that we know as tungsten (meaning "heavy stone" in Swedish) will henceforth be called wolfram, a word of German origin that has been used for a long time in most European countries.

Other official designations of natural elements are beryllium rather than glucinum, niobium rather than columbium, lutetium rather than lutecium, protactinium rather than protoactinium, and hafnium for Element No. 72. The name plutonium was confirmed for the fissionable synthetic element created and so called by the nuclear physicists. Others in this category, which likewise are to be known by the designations their discoverers gave them, are neptunium, americium, curium, and promethium.

150 YEARS OF SERVICE

WITH the President and other high governmental dignitaries in attendance, our Naval Gun Factory in Washington, D. C., celebrated its 150th anniversary early last month. The establishment has made long strides since it was set up on a marshy plot on a branch of the Potomoc River by the then newly organized Navy Department. By any standard of comparison, it is now recognized as the equal or superior of any similar plant in existence, and it goes without saying that its comparative standing will not be allowed to deteriorate.

During its first 82 years of existence the factory made few of our naval guns. They were cast in private plants under contract, and the Navy Department contented itself with conducting research and experimental work. Its role was changed in 1882 when Congress, aware of our weakness in naval armament, appropriated funds to construct four steel ships that were to become the nucleus of our "New Navy." Coevally with that move, the Secretary of the Navy called attention to our lack of equipment for making the steel forgings necessary for heavy rifled cannon and urged that this situation be remedied.

Fortunately, his words were heeded, the facilities were provided, and the Naval Gun Factory entered upon a planned program of turning out the weapons and all related equipment that have ever since given our fleets formidable fire power. During periods of peace it can do the job pretty much by itself. In times of national emergency, however, it calls for and receives help from numerous industrial firms, all operating under the strict control of our naval experts.

During World War II, these outside facilities were expanded until they included fifteen naval ordnance plants, 1800 prime contractors, and 25,000 subcontractors. Despite this great spreading out of the work, the requisite components of our naval rifles and the vast array of their accessory equipment, mountings, etc., were manufactured to uniform standards, both as to materials and dimensions. The achievement of these objectives obviously called for highly coördinated direction by the naval-ordnance experts and splendid coöperation on the part of thousands of skilled American workmen.

ENGINEERING SOCIETIES

IN THE year 1839 forty engineers from eleven of the twenty-seven states then in the union met in New York to exchange ideas relating to their profession and proposed the formation of a permanent organization. From this initial conclave came the American Society of Civil Engineers, oldest of the four leading national engineering groups. It took thirteen years for the suggestion to mature, for the society was not founded until 1852. Even then there were so few engineers in the country that it was deemed advisable to open the membership to "civil, geological, mining, and mechanical engineers, architects, and other persons, who, by profession, are interested in the advancement of science."

Nearly two decades later, in 1871, the second important technical professional organization came into being with the formation of the American Institute of Mining & Metallurgical Engineers. It was followed, in 1874, by the American Institute of Electrical Engineers. The last of the "big four," the American Society of Mechanical Engineers, was founded in 1880. Collectively and individually, they have done much to advance the status of the engineering professions. They jointly own a headquarters building in New York City that includes one of the best-stocked technical libraries in the United States. Each group has subsidiary branches throughout the country, and these hold regular meetings for the interchange of ideas, much as the original 40 founders did in New York. Budding engineers in technical colleges also are organized under a special classification.

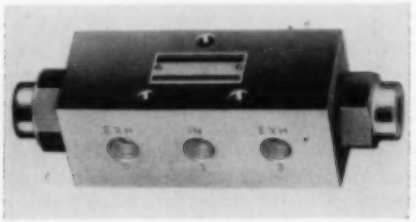
The civil engineering group, as well befits the first in the field, has grown to a lusty membership of more than 26,000.

Industrial Notes

Production of a new type of spray nozzle on which patents are pending has been announced by the Bete Fog Nozzle Company. As the accompanying illustration shows, it is of spiral design devoid of vanes or whirl disks. It is claimed that extremely fine atomization is obtained at relatively low pressures and that nozzle is virtually nonclogging. Models with flow rates from ¼ to 100 gpm. and in various spray patterns are available.

After more than a year of testing, the E. D. Bullard Company has announced a style change in safety headgear. It's latest Hard Boiled Hat has a crown of resin-impregnated Fiberglas, which exceeds other materials used in strength and resiliency. It is also said to be impervious to moisture and acids; nonshattering and nondeteriorating; and more comfortable than metal from a temperature standpoint. Standard types are white and gray, but hat can be made in any color. For night construction crews and underground workers where visibility is desirable there is one that glows in the dark. The sweatband is adjustable to fit all head sizes.

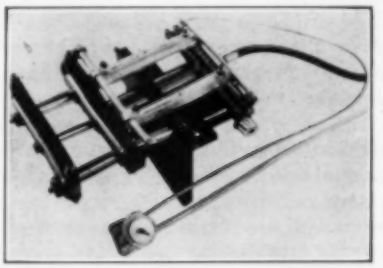
C. B. Hunt & Son, Inc., has introduced a new line of double-piloted single-plunger valves for air, oil, or water at line pressures up to 125 psi. (also vacuum) and temperatures not exceeding 150°F. As pilot cylinder functions at a



pressure as low as 25 psi., valves are suitable for use in connection with safety controls on presses, shears, cutters, etc.; air clutches; and sequence operating cycles. They are available in five models (2-, 3-, 4-, and 5-way and double 2-way) tapped for ⅛- and ¼-inch pipe connections. The change in design, reports the manufacturer, has prolonged the service life of packing and valve parts, has reduced repair and maintenance to a minimum, and permits complete dis- and reassembly in a few minutes without disturbing the main piping.

Under a recent plan of reorganization, the U.S. Bureau of Mines, now 39 years old, is being divided into nine regions for closer contact with mining activities and to provide better and more efficient service. Seven of these will be in the United States, and Alaska and all foreign countries will each come under one head.

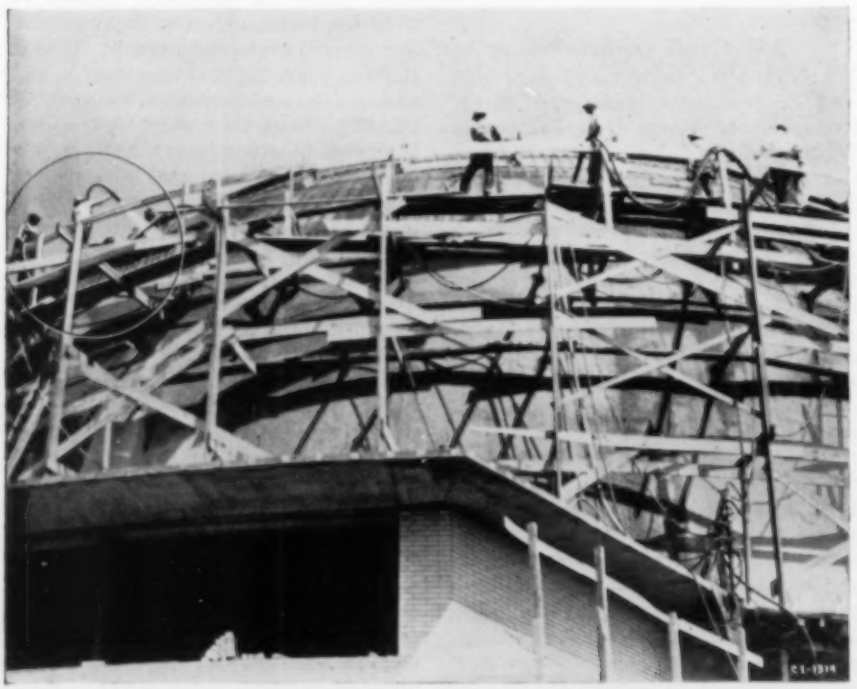
For feeding sheets, channels, bars, etc., into punch and drill presses, spot welders, and other machines, Great Western Tools, Inc., has designed an air-operated unit called the Feedmaster. It is shown with the cover removed and can be mounted by two cap screws to feed left to right, right to left, front to back, or push-pull. Stock up to ¼ inch



thick and 8 inches wide (width can be increased to 15 inches by a simple attachment) can be handled and is passed through two heads—a movable feed head, which is fastened to a pneumatic piston, and a stationary hold head. Length of feed from 0 to 6 inches can be adjusted to micrometer accuracy, but longer increments are possible by tripping the control valve more than once during a single machine cycle. Using air at 30 psi., the automatic Feedmaster can be operated at 300 strokes per minute, it is claimed.

Now that the days of "sniffles" are with us it is interesting to learn that the air purifier Vapor Roll, marketed by Air Purification Service, Inc., has been made attractive for home use by encasing it in plastic. The unit looks like a radio and measures 7x8x14½ inches. It is electrically heated and gives off odorless glycol vapor which is known to kill many of the germs, viruses, and bacteria that cause respiratory infections.

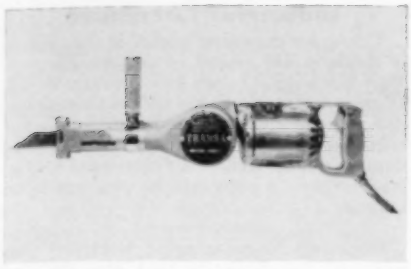
Production and maintenance men have been provided with a new tool that is said to cut anything from rubber to stainless steel. It's a reciprocating gun-



COMPRESSED AIR AND GAS INSTITUTE PHOTO

BLOWING ON A ROOF WITH COMPRESSED AIR

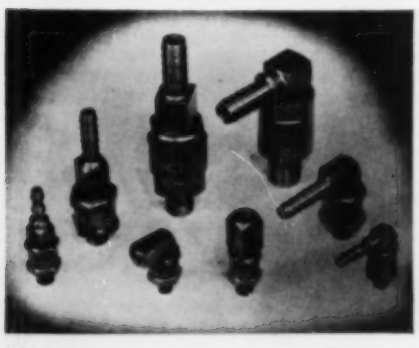
A view during the construction of the hemispherical dome of the Park Temple of the Jewish Center in Cleveland, Ohio, showing Gunite being applied to reinforcing steel with air at 30 psi pressure. To literally shoot the mixture of sand, cement, and water into place against a wooden form, three crews worked fifteen 9-hour days. Three compressors supplied a total of 9 million cubic feet of air to cover the 18,000 square feet of surface of the 100-foot-diameter roof which, when sheathed with copper, will weigh 500 tons. It rises 85 feet above ground level and is supported by six reinforced-concrete pillars that rest on bedrock. The area beneath will be an auditorium with a seating capacity of 1000. The building is part of a $1,500,000 development and was designed by Eric Mendlesohn, the architect of the Hadassa Hospital in Palestine.



type saw that can be driven at variable speed by a pneumatic or electric drill or by a flexible shaft. The stroke is adjustable from 0 up to 2 inches to facilitate cutting materials of different thicknesses. Blades ranging in width from ½ to 1 inch are used and are prevented from whipping by special guides, one for each size, that also serve as sights in following a line. The tool handle can be moved forward and backward, swiveled 360° to cut at any angle with ease, and locked in any position. The saw is manufactured by Transa, Inc.

In reporting on its improved No. 905 grade of cemented carbide for finishing and light roughing cuts on nonferrous metals and cast irons with a hardness up to Brinell 550, Carboloy Company, Inc., states: The new material is even harder and more wear resistant than the old, and tools tipped with it have a longer service life and do a better job of holding size on long cuts. Performance has also proved that heat is carried away faster from the cutting edge. Used in the precision boring of back bearing holes for crankshafts in cast-iron cylinder blocks, the tools are finishing 2000 pieces per grind, or double the number previously considered highly satisfactory. Many sizes and types of standard tools and blanks in the improved Grade 905 are carried in stock.

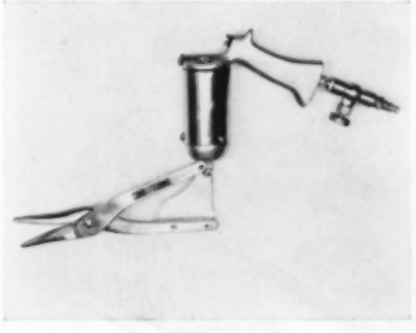
A new line of swivel connectors for air-operated tools of all kinds is being produced by The Cleveland Vibrator Company. They are available in straight or "ell" types of rust-resistant steel for hose from ¼ to 1 inch in diameter and piping from ⅛ to 1 inch.When used at the air intake of pneumatic grinders, chippers, wrenches, hammers, paving breakers, spray gun, etc., they provide full 360° swivel action that facilitates tool handling and changing and lengthens the service life of hose by obviating needless kinking and buckling. They are said to be airtight.



Ohio is said to lead all other states in the union in the number of foundries. Penton's List gives it a total of 585, which is fourteen more than in 1947 when the last compilation was made.

According to a recent announcement by the U. S. Bureau of Standards, the name Celsius was adopted at the General Conference on Weights and Measures for the Centigrade temperature scale. This is fitting, because the scale was invented by Anders Celsius, a Swedish astronomer, in 1742.

Pneumatic shears for cutting sheet metal including aluminum, brass, copper, and steel up to 16 gauge, are being offered by the Bud Manufacturing Company. They are light in weight and well balanced for ease of operation. Can be



used in connection with any compressor delivering 2.7 cfm. or more and will cut straights, contours, and designs by slight thumb pressure on the valve-control button at the top of the handle. Tool is also suitable for cutting roofing and flooring materials.

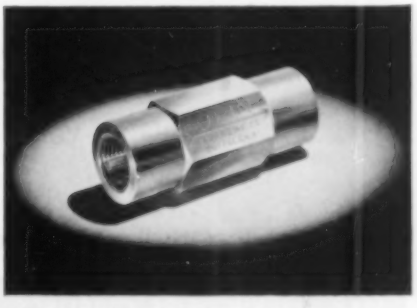
Steel shelving that can be assembled without the use of nuts, bolts, or screws has been announced by Equipto, a division of the Aurora Equipment Company. Only studs are required to make up open or closed units, parts bins, and counters that can be added to or rearranged. Each stud slips into a hole in the shelf and into a keyhole in the upright. Down pressure on the shelf, when both sides have been secured, completes the assembly. To take a unit apart, the shelves are simply raised and the studs are withdrawn. Each shelf has a capacity of 600 pounds, with reinforcements added it may be increased to 2000 pounds.

Western Sealant, Inc., has introduced two new metallurgical products for manual application: Flawmaster and Bonding Agent R-313. The first is a thermosetting compound for reclaiming metal parts and castings rejected for surface flaws, sand pitting, foundry gas holes, taps, and other defects. It is said to be machinable, chemically inert, and to resist a wide range of temperatures. The other is suitable for bonding dissimilar and similar materials such as glass, plastics, neoprene, and leather to metals; ferrous to nonferrous metals, etc. It has high chemical and temperature resistance.

After years of experimenting, a member of the Cleveland, Ohio, fire department has invented a valve that automatically shuts off gas mains in case of major fires. According to a testing laboratory, the device is virtually foolproof. It is installed between the meter box and the intake feed line.

Savings of as much as 50 percent in water-soluble cutting oils are claimed by The Beacon Rust Proofing Mfg., Co., for its 501 Oilsaver, which can be used with most oils of this type in a wide range of dilutions. Added in the proportion of 1 to 400 parts of water, there is no loss in coolant standard, and an imperceptible film left on surfaces with which it comes in contact protects machinery against rust. The compound is also said to be noninflamable and nontoxic. Company is offering a test kit free. Request should be addressed to 20 E. Thirty-third Street, New York 16, N. Y., and accompanied by a description of the machining operation, metal worked, cutting oil, and a dilution formula.

Safety and time saving are the purposes of Olin Gas Engine Company's new shut-off valve for lines carrying compressed air and other gases, as well as steam and light liquids under pressure. It is made to fit standard connections and is inserted at the intake end of an air hose. Should the latter break, the valve closes instantly and shuts off the pressure, permitting only a light stream of air to escape through a by-pass. When the hose is repaired, the valve is auto-



matically opened by a spring and pressure is restored. Other claims made for it are that it permits changing tools without closing a valve, does not restrict the flow or reduce the volume of air being used, and will operate under varying pressures. Made of brass it will not corrode, and with only one moving part requires no attention when once installed.

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Industrial Literature

Piping for corrosive liquids is the subject of Bulletin 485 issued by Taylor Forge & Pipe Works, P. O. Box 485, Chicago 90, Ill. It deals comprehensively with stainless-steel and nickel-alloy piping and includes dimensions, specifications, and other technical data on pipe as well as stainless-steel fittings and flanges. A copy will be sent free upon request.

Rockwell Manufacturing Company has prepared two bulletins that give detailed information and operational data on Hypermatic, a new lubricant for Nordstrom valves. It is a plasticlike material that is said to be compressible when placed in a valve and put under pressure by a screw or other device and that absorbs and stores energy to provide positive lubrication over a long period of time. Copies can be obtained from the Nordstrom Valve Division of the company at 400 North Lexington Avenue, Pittsburgh 8, Pa.

General Electric Company, Schenectady 5, N. Y., will send upon request a 20-page catalogue giving details, specifications, and prices of more than 150 arc-welding accessories including electrode holders and carriers, tungsten electrodes, cable connectors, ground clamps, brushes, cleaning tools, fillet-weld gauges, helmets, goggles, and protective clothing. According to the company, the products listed will meet all ordinary welding requirements, as well as many special ones. Requests should be made for Bulletin GEC-253A.

A handbook of special fastening devices for industrial application may be had from South Chester Corporation, Finance Building, Philadelphia 2, Pa. They have a wide range of uses and are suitable for fastening metal to metal, wood to metal, etc. Blind rivets, anchor nuts, panel fasteners, and door-retaining springs, as well as many newly developed products, are among those listed. Dimensioned drawings, specifications, and construction details are included in the handbook.

Two new bulletins on hose products are obtainable from The B. F. Goodrich Company, Akron, Ohio. No. 4460 gives information about the firm's sand and cement hose. Three types are described: Sand-discharge and placement hose, cement-handling hose, and grout hose. Tables of specifications and operating data for each are given. No. 4200 provides illustrations, construction data, and other facts about its line of welding hose. Copies of both bulletins will be sent upon request.

Starting devices for electrical motors is the subject of Bulletin No. 14B7215 of Allis-Chalmers Manufacturing Company. They are of the manually operated, reduced-voltage, auto-transformer type designed for use with 2-phase, 3-wire or 3-phase motors in driving pumps, blowers, conveyors, compressors, fans, or other machines where reduced-voltage starting and manual control are desired. Designed for nonreversing duty, they provide high starting torque, adjustable voltage taps, and under-voltage and thermal-overload protection. The starters are available in sizes to control motors up to 125 hp. at 220 volts, up to 150 hp. at 440-550 volts, and from 15-150 hp. at 2000-2500 volts. Copies of the bulletin will be sent upon request to the company at South 70th Street, Milwaukee, Wis.

Valvair Corporation, 454 Morgan Avenue, Akron 11, Ohio, will send to interested persons a folder describing the company's line of air-control valves that feature sliding stems which move within a series of specially

designed packing rings to seal off the air or let it flow without the use of a metal seat. They are said to remain leakproof over a long period of time. Also available is an 80-page catalogue showing dimensional drawings of typical valve layouts, control assemblies, and mounting brackets.

Fabricated steel products for the chemical industry are dealt with in a 20-page catalogue obtainable from Black, Sivalls & Bryson, Inc. Gas dehydrators, tubular and indirect heaters, chemical feeders, gas scrubbers, wood and steel tanks, walkways and stairways, loading racks, etc., are described and illustrated, and charts and engineering data give capacities, ratings, and specifications. Also available is an 8-page booklet covering safety heads; safety-head flanges, rupture disks, and relief valves; and pressure-vacuum vent valves. Copies of both may be secured by writing to the company at 720 Delaware Avenue, Kansas City 6, Mo.

Reinhold Publishing Corporation has announced the publication of the 34th edition of its *Chemical Engineering Catalog*. Intended principally for operating and research personnel of industries using chemical processes of manufacture, the book contains data on sources of raw materials, heavy and fine chemicals, engineering equipment and machinery, etc. Descriptions of each product listed have been condensed and standardized where possible. The content is separated by classified indices and carefully cross-referenced to make the 1580-page publication easy to use.

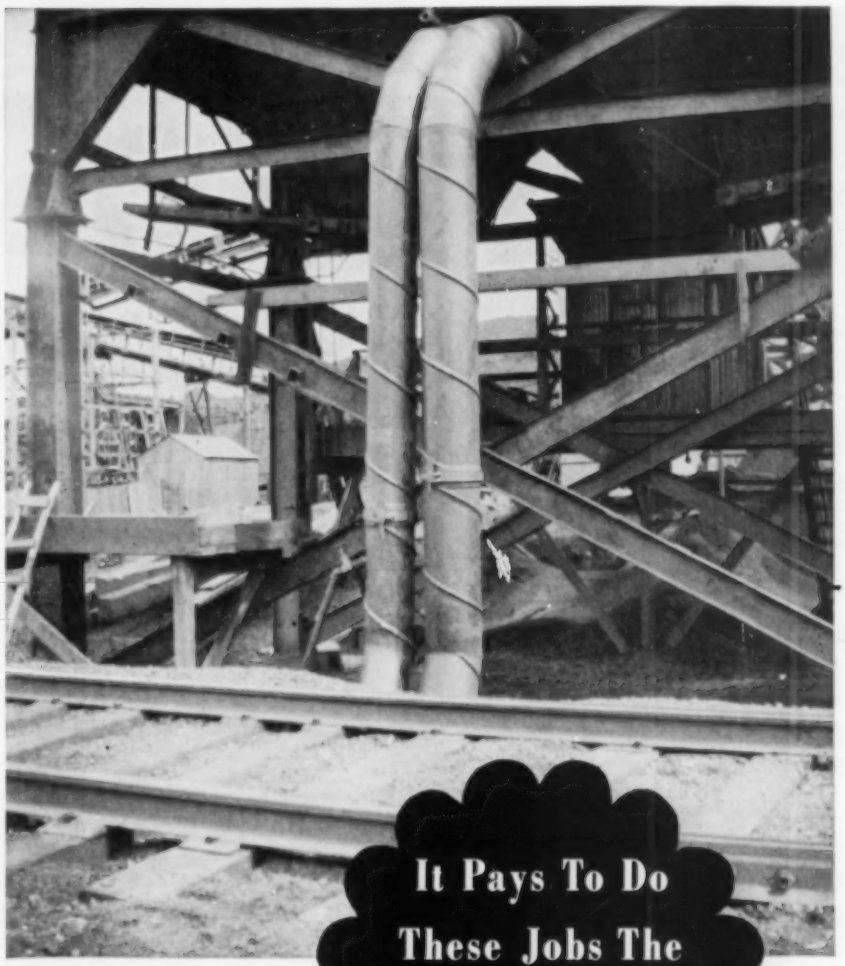
The 1949-50 volume differs from previous editions in that the chemical and raw-material sections have been separated from the main body of the book and bound separately under the title "Chemical Materials Catalog." This was done to give research directors, chief chemists, technical directors, and others holding similar positions a reference book, one containing technical details on products available to them.

Persons interested in obtaining a copy of *Chemical Engineering Catalog* should write to the publisher at 330 West 42nd Street, New York 18, N. Y., stating company and position.

The third revised edition of *The Manual of Accident Prevention in Construction* has been published by The Associated General Contractors of America. Comprising 264 pages and containing more than 100 photographs and drawings, the book is more complete and better illustrated than its predecessors. It has the same objective: To explain the safe ways of performing construction work and to emphasize the costly results of incorrect, unsafe practices.

According to the manual, accidents during 1948 cost the industry and the nation some 787 million dollars. If half of them had been prevented by the use of practical, common-sense safety measures, a saving of nearly 400 million dollars would have resulted, to say nothing of the benefits derived from improved working conditions, avoidance of suffering, and conserved man-power.

The manual has been written primarily for superintendents, foremen, and others whose positions carry with them the responsibility of leadership in the prevention of accidents. New sections which have been added are: Housekeeping; oxygen, acetylene, and hydrogen gases; electric welding; power saws; explosive gases and liquids; motor graders, bulldozers, and tractors; and boats and barges. The manual has been so proportioned that the pages can easily be scaled down to provide pocket-size reprints of any individual section. It sells for $3, postpaid, and can be obtained from the association at The Munsey Building, Washington 4, D. C.



It Pays To Do These Jobs The NAYLOR Lightweight Way

You get the advantages of lightweight lines when you use Naylor Pipe. Its distinctive Lockseam Spiralweld structure produces pipe that is light in weight yet provides the strength and safety required in mining service. Add to this performance the speed and economy of Naylor Wedge-Lock Couplings and you have a combination not found in ordinary lightweight pipe.

Sizes from 4 to 30 inches in diameter—thicknesses from 14 to 8 gauge. All types of fittings, connections and fabrications.

Write for Catalog No. 44.

Specify NAYLOR PIPE for These Applications

AIR LINES—high or low pressure
WATER LINES—high or low pressure
HYDRAULICKING
DRAINAGE
SUCTION LINES
SLUDGE LINES
VENTILATING LINES

Naylor Pipe

NAYLOR PIPE COMPANY
1245 East 92nd Street, Chicago 19, Illinois
New York Office: 350 Madison Avenue, New York 17, N. Y.

Worried ABOUT YOUR COMPETITION?

Do your competitors produce more in less time at lower costs? Maybe they're doing it with Air Tools.

Ingersoll-Rand Air Tools will quickly and efficiently —drill—ream—tap—rivet—cut—chip—hoist—haul —grind—run nuts and drive screws. Air Tools will do all these jobs and many more in less time and at lower cost. Dependable, light, fast I-R Air Tools are the choice of realistic production men.

A manufacturer of electrical equipment installed three Air Powered Screw Drivers costing $240.00. The time saved on this application enabled him to improve his competitive situation and the tools paid for themselves in twenty-four days.

Perhaps there is an Air Tool which will do a better and quicker job for *you* in *your* plant. Ask one of our Air Power Specialists to *show you how I-R Air Tools pay for themselves nearly twice as fast under today's conditions and enable the workman to do more work with less effort.*

AIR POWER
The Key to Lower Production Costs

Send for Form 5010A, containing over 30 pages of remarkable time and money savings made with Air Tools.

403-8

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS · AIR TOOLS · ROCK DRILLS · TURBO BLOWERS · CONDENSERS · CENTRIFUGAL PUMPS · OIL AND GAS ENGINES

Cut pressure losses with 50% lighter air hose

New B. F. Goodrich Highflex hose cuts weight, adds flexibility

NO MORE big pressure drop from compressor to tool, because of using a "too small" i.d. hose in order to get flexibility. New B.F.Goodrich Highflex air hose weighs 50% less than ordinary air hose of the same size, has greater flexibility. It allows the use of adequate-size hose to prevent excessive pressure drop; yet without sacrifice of a light, flexible line.

50% less weight — Here's a hose line that is truly lightweight, yet adequate to deliver the pressure the tool requires. You save 11.2 lbs. in just 100 ft. of this new hose in ¼" size! Substantially similar weight savings in all sizes.

Higher flexibility — With Highflex, workers can more easily work in close quarters. They tire less easily, can increase production.

High working pressure — Highflex has a rating of 250 lbs. working pressure. Single ply, double braid construction. Low expansion under pressure, minimum contraction of length.

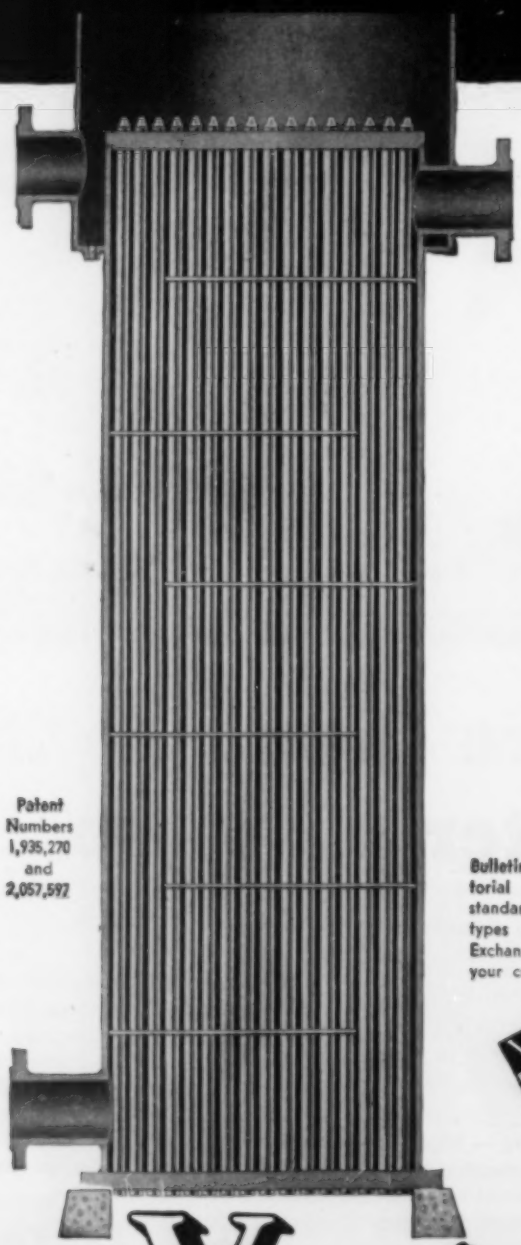
Completely oilproof — Properly lubricated tools last longer. With Highflex hose you can lubricate without fear of oil causing hose to swell or flake, to cut air volume or jam the tool. Dragging Highflex through oil won't harm the cover.

More features — A red cover of high visibility makes Highflex easy to keep in sight. Cover resists checking, snagging, and abrasion. Its lighter weight takes up less room when stored. Ask your BFG distributor to show you this new air hose. *The B.F.Goodrich Company, Industrial and General Products Division, Akron, Ohio.*

Air Hose
BY
B.F.Goodrich

FILM TYPE EXCHANGERS

DETAIL SHOWING DISTRIBUTING FERRULE IN TUBE (Patent Pending)



Patent Numbers 1,935,270 and 2,057,592

Vogt engineers have taken a familiar refrigeration plant "old timer" and developed it into this modern, efficient heat exchanger.

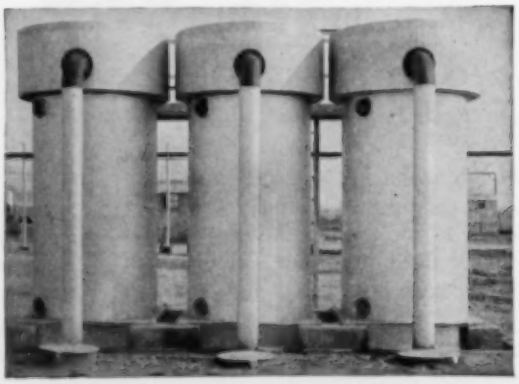
The film type exchanger operates in a vertical position. Water introduced in the top chamber is distributed in a thin film against the inner tube walls by means of special ferrules. The shell side of the exchanger has baffles arranged to provide optimum velocities, pressure drops, and heat transfer rates. Shutdowns are eliminated because tubes can be cleaned while the unit is in operation; thus permitting the use of dirty, mud and silt depositing water.

Vogt Film Type Exchangers now serve as Jacket Water Coolers, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to condense any vapor. They are also applicable for handling liquids other than water in film flow.

HENRY VOGT MACHINE CO., INC.
LOUISVILLE 10, KENTUCKY

Branch Offices: New York, Philadelphia, Cleveland, Chicago, St. Louis, Dallas

Bulletin HE-5 is a pictorial presentation of standard and special types of Vogt Heat Exchangers. Write for your copy.

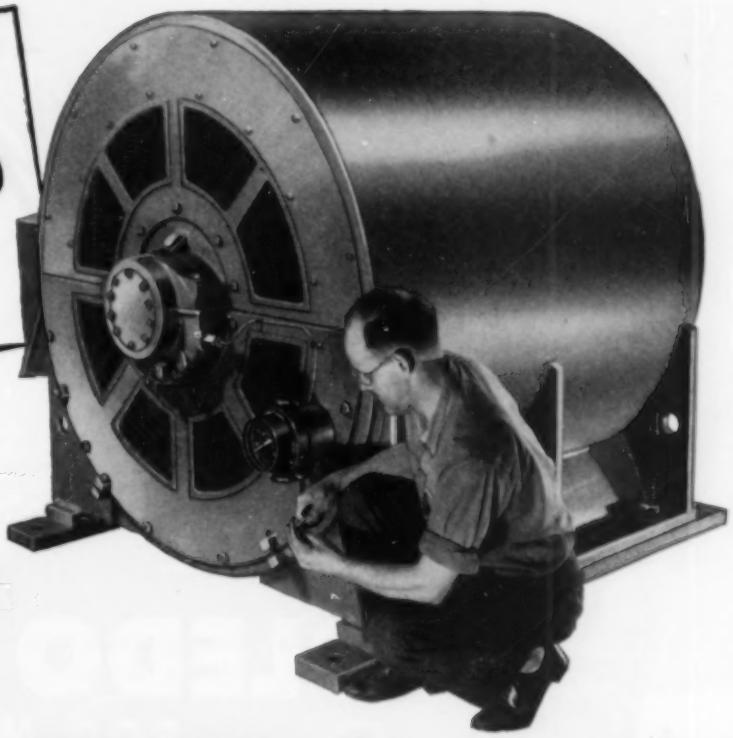


Jacket Water Coolers serving engines of 7,300 H.P. Muddy well water used as cooling medium.

Vogt

HEAT TRANSFER EQUIPMENT

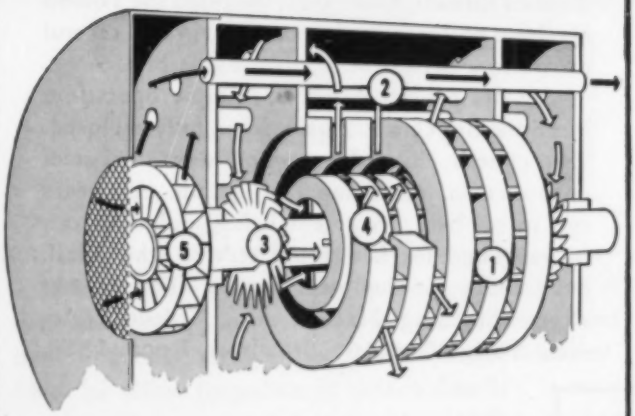
TUBE-TYPE TOTALLY-ENCLOSED FAN-COOLED MOTORS!



DIRT-PROOF!

AND CORROSION-RESISTANT!

How Tube Cooling Works



Stator core (1) is surrounded by tubes (2). Internal fans (3) circulate air through ducts (4) in rotor and stator and around tubes, transferring heat to tubes.

External fan (5) drives outside air through tubes, removing heat and keeping tubes clean. All electrical parts are enclosed. Dirt cannot enter.

*Totally-Enclosed Fan Cooled

- **Install anywhere – indoors or out**
- **Heat exchanger is practically *self-cleaning***
- **Sizes . . . 75 to several thousand horsepower**

THIS ALLIS-CHALMERS tube-type TEFC* motor practically eliminates cleaning and other high maintenance costs associated with large motors exposed to dirty and corrosive atmospheres. And it does this with a simple, self-contained, tube-type, ventilating system.

All electrical parts — including the stator core — are enclosed. The simple heat transfer system keeps temperatures well within rated limits. Cleaning is rarely needed because air passages are unrestricted. Air flow through the straight tubes removes foreign matter.

Three years of field operation have proved important savings. Sizes from 75 hp and up. Also explosion-proof designs. For complete information, outline your requirements to your A-C Sales Office, or write for Bulletins 05B7150 and 51R7149.

A 2664

ALLIS-CHALMERS, 1000A SO. 70 ST.
MILWAUKEE, WIS.

ALLIS-CHALMERS

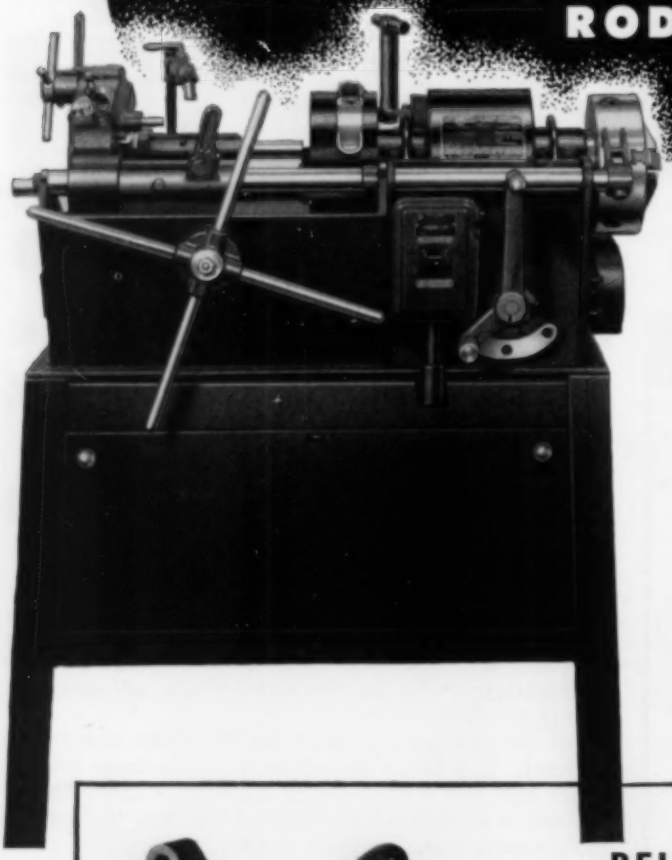
Keep 'em Drilling

AT MINIMUM COST!

thread your drill rod

ON THE JOB

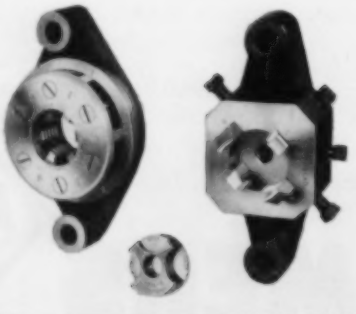
with a TOLEDO ROCK DRILL ROD MACHINE



Keep your drill rod in service *at minimum cost*—use a TOLEDO 2″ High Speed Rock Drill Machine! Will thread new or re-thread broken drill rod *right on the job*—at a fraction of the cost of a new rod. Reduces downtime and expense.

Can be tooled to produce Ingersoll-Rand and Timken threads. After rod is annealed the Toledo Machine will turn to size, thread and face off end of rod to a perfect fit for detachable bits.

Sturdy, proven design . . . simple operation. Multiple disc clutch. Chain drive, fully enclosed. Two chucks. Round renewable ways. All steel construction. Centrifugal oil pump. All gears run in oil bath. Segmental dies and tools can be reground for additional service when dull. Send today for complete details. The Toledo Pipe Threading Machine Co., Toledo Ohio. New York Office: 165 Broadway, Room 1310.



Die head and dies, tool box and cutters for turning and forming Timken rods, and special stop for setting the cutters to size are shown here.

RELY ON THE LEADER

TOLEDO

for ROCK DRILL ROD MACHINES

THE MARKS OF *Fine Drill Steel*

You can make sure you're using Bethlehem by looking for the "A" and "B" markings in groups of six which are rolled on every bar of drill steel at 30-in. intervals. These smooth, raised letters have no sharp lines that could serve as origins for fatigue cracks. Having six marks in a group assures ready identification, even after a bar has seen rough service.

Hard-rock men who have compared drill steels have learned to identify Bethlehem Hollow by its consistently top performance. The bar markings are added assurance of your getting what you specify.

β for Carbon

This fine-quality carbon steel is the standard type of drill steel, the "Old Reliable." It's easy to forge, and its wide quenching range assures easy heat-treatment. Ideal for either forged-on or detachable bits. It stays on the job because it has the dependable quality which stems from controlled hardenability and rigid inspection, a technique we've perfected to insure uniform toughness, long wear and fatigue-resistance.

a for Alloy

This excellent alloy grade, developed to give better service as drill rod for use with detachable bits, has been thoroughly proved by many users who prefer the alloy type of drill steel. It cannot be used for forged-on bits. Its extensive use has demonstrated the fine performance that can be expected when it is properly heat-treated. Developed first by Bethlehem, this alloy drill steel meets I-R Specification 139.

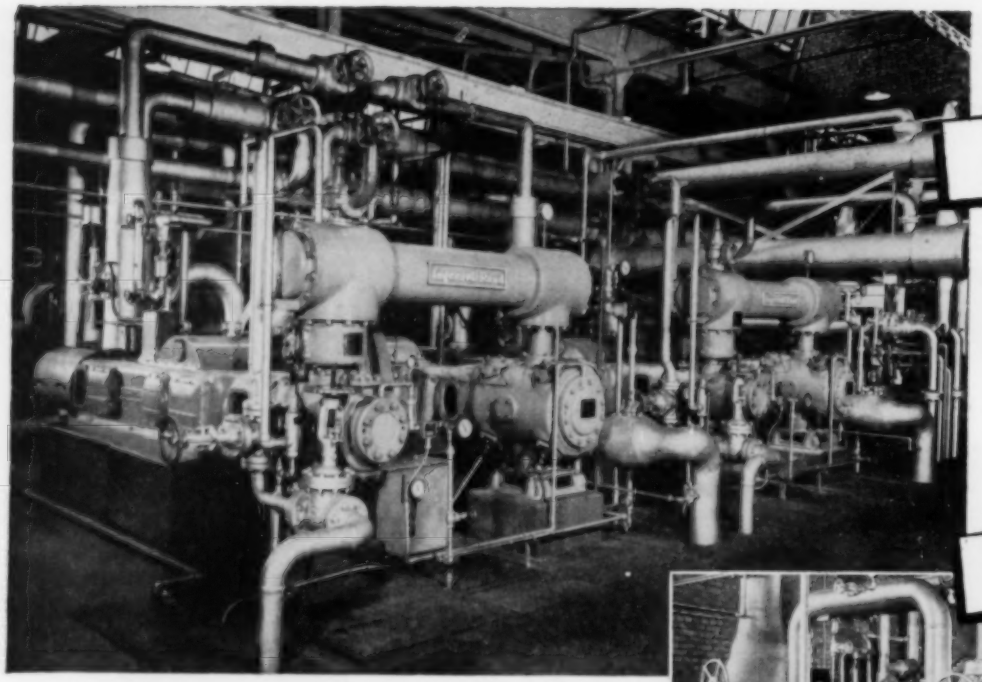
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

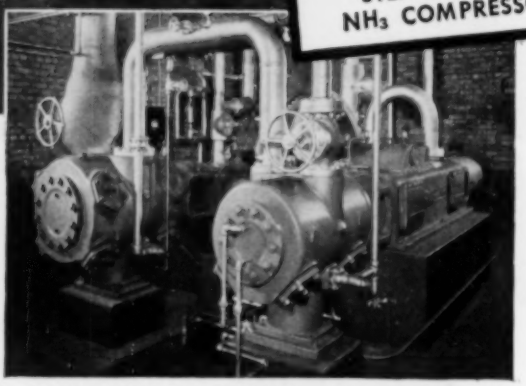
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM HOLLOW DRILL STEEL

BETHLEHEM STEEL



STEAM-DRIVEN CO_2 COMPRESSORS



STEAM-DRIVEN NH_3 COMPRESSOR

At New "DRY-ICE" Plant

PURE CARBONIC

INCORPORATED

Depends on IR COMPRESSORS

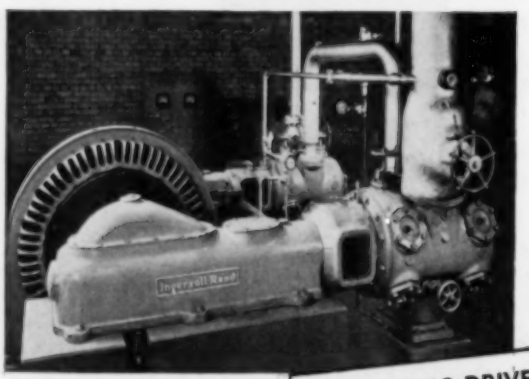
Seven Ingersoll-Rand compressors totalling 1450 hp, in the new Chicago carbon-dioxide plant of Pure Carbonic, Incorporated, help produce 150 tons of "DRY-ICE" daily... for food industries and manufacturers of resins, paints, rubber, plastics, ceramics, pharmaceuticals, petroleum products, and fire extinguishers.

Four 200-hp compressors handle CO_2 gas, compressing it from 35 to 360 psi. These are the well-known Ingersoll-Rand Type XPV steam-engine-driven compressors noted for their simplicity, adaptability to varying conditions, economy, and smooth operation in process service.

One of the ammonia-refrigeration compressors is of the same steam-driven type. The other two, 150 hp each, are of heavy-duty, double-acting, synchronous-motor-driven design.

During the 40 years it has been producing carbon dioxide, Pure Carbonic, Incorporated, has installed Ingersoll-Rand compressors in several of its other plants.

Ingersoll-Rand has had long experience in designing and building process compressors for practically all pressures and all kinds of gases in sizes up to 3000 hp. Qualified compressor specialists are located in I-R offices all over the world. Call upon this experience when you need help in solving a problem of air or gas compression.

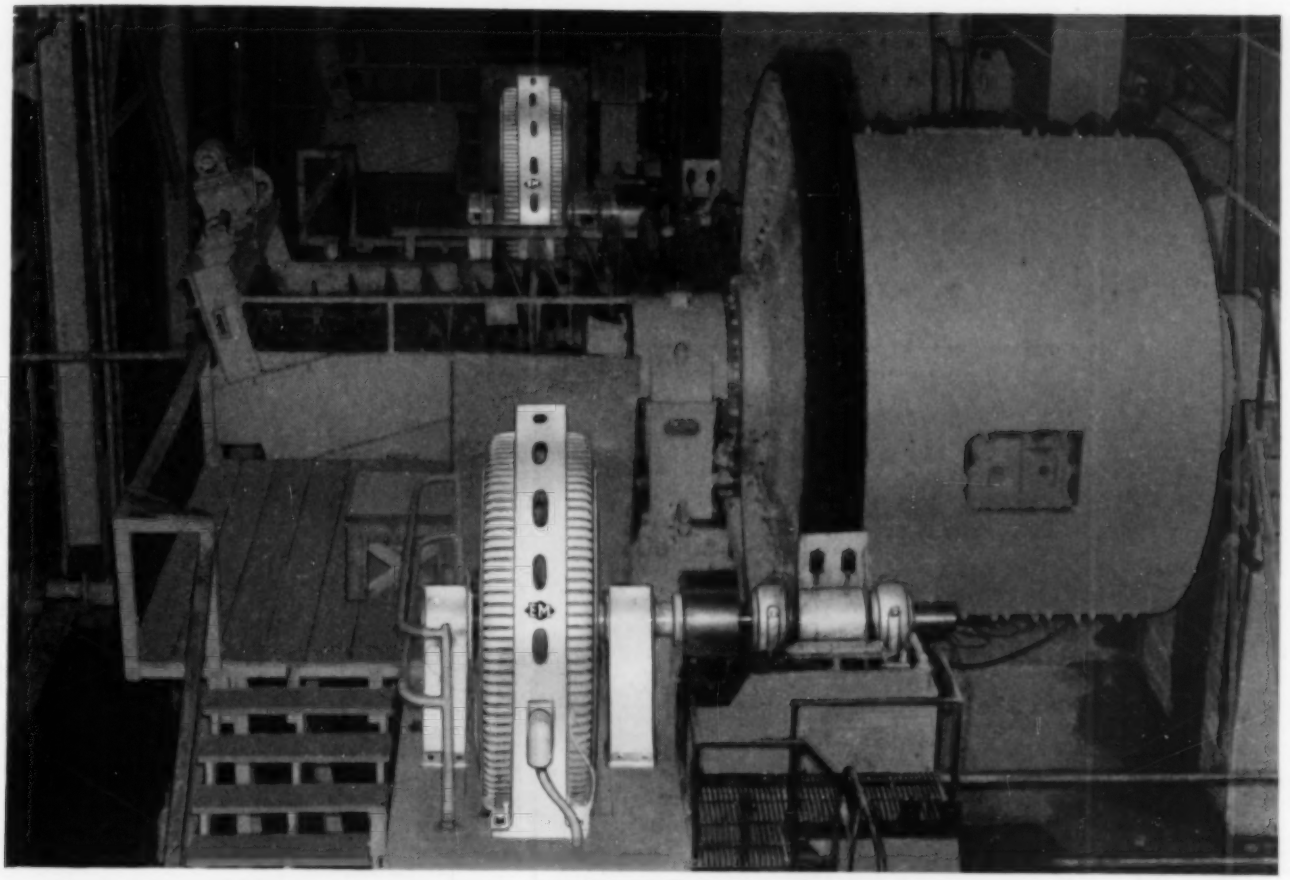


ELECTRIC-DRIVEN NH_3 COMPRESSOR

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 457-1

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • OIL AND GAS ENGINES



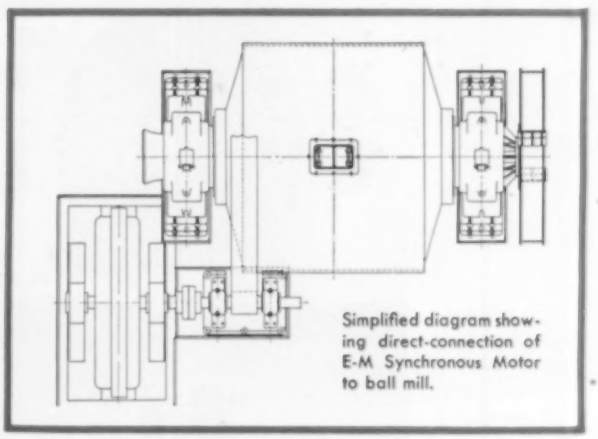
Biting off a bigger mouthful with direct-connected E-M Synchronous Motors

"Move more ore . save more space . . . cut power costs to rock bottom!" That was the recipe for profitable handling of low-grade ore, in new block-caving operations at the Bunker Hill and Sullivan mine, at Kellogg, Idaho.

The picture above shows how neatly the job is being done —with the simple, compact installation of E-M Synchronous Motors.

In this application two 400 horsepower, 240 rpm, high-torque E-M Synchronous Motors supply the drive by direct connection to 10′6″ x 8′0″ cylindrical ball mills, largest of their type to be installed recently. This compact drive provides highest efficiency in power conversion, high power factor, and high stability.

Wherever power costs are vital, wherever space is at a premium, direct-connected E-M Synchronous Motors offer important and inherent advantages, such as paying their own way in power factor improvement. These economical and dependable constant-speed drives are ideal for ball and tube mills, jordans, lineshafts, pumps, compressors.



Simplified diagram showing direct-connection of E-M Synchronous Motor to ball mill.

Write today for full information about E-M Synchronous Motors—the most efficient constant-speed drive in industry. Ask for Bulletins 175 and 181.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

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E-M

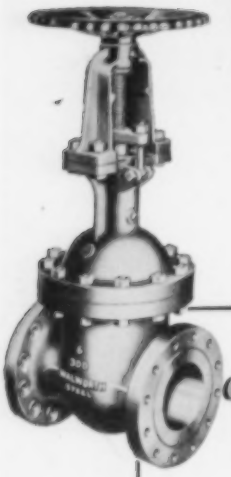
SPECIALISTS IN BIG MOTOR ENGINEERING

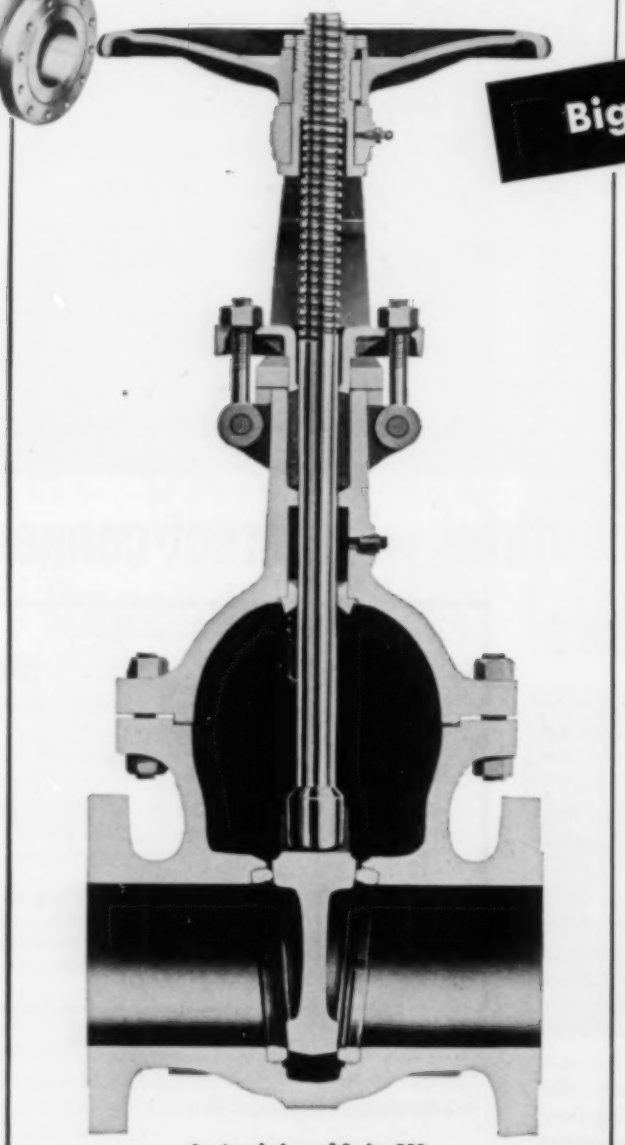
WALWORTH

Cast Steel Gate Valves

Series 150 and 300

Wedge Gate — Outside Screw and Yoke





Sectional view of Series 300

Big 8-Point Superiority!

Gland clearances are such that stem cannot be scored if gland should be tightened unevenly.

Deep Stuffing Boxes in all sizes (2″ to 24″) insure tightness and maximum packing life – costly leaks are eliminated.

Bonnets and Bodies are engineered to withstand pressure and minimize distortion – they're tough, durable, dependable.

Heavy Steel Walls provide extra strength and longer life.

Integral Body Guide Rib Faces are machined to insure accurate disc seating.

Seat Rings are bottom seated – not flange type. No recess exists at back of ring – hence no turbulence, erosion, or pressure drop.

Streamlined Ports allow high velocity, non-turbulent flow, and reduce the possibility of erosion.

Valves regularly have flanged ends. They can be supplied with ends for butt welding. Roller bearing yokes are available. On valves 5 inches and larger, by-passes can be furnished.

For Series 600 and higher, we recommend Walworth Pressure-Seal Steel Gate Valves.

For further information on Walworth Cast Steel Gate Valves, see your local Walworth distributor, or write:

WALWORTH

valves and fittings

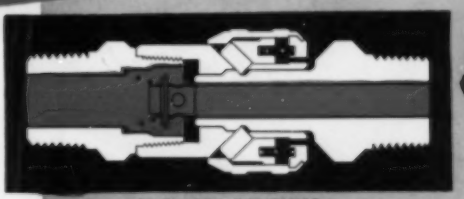
60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

SAVE ✔TIME ✔TROUBLE ✔MONEY WITH THESE HANSEN COUPLINGS

HANSEN PUSH-TITE COUPLING
Shuts off one side of line

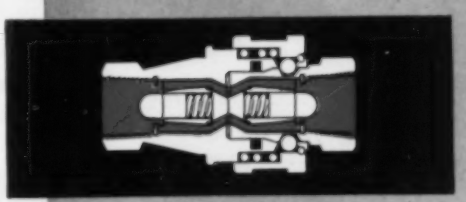
Gives quick connection and disconnection, with instant automatic flow or shut-off. To connect coupling, and open line to flow of fluid, merely push plug into socket. To disconnect, a slight pull on sleeve releases plug and shuts off supply end of line.



PUSH-TITE COUPLING

HANSEN HIGH PRESSURE TWO-WAY SHUT-OFF COUPLING

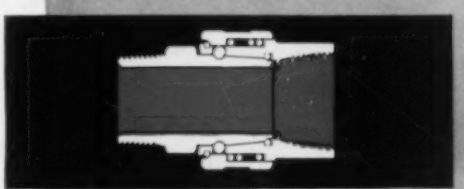
To connect, pull back sleeve and push plug into socket. Identical torpedo type valves permit free flow of gas or liquid through coupling. To disconnect, pull back sleeve . . . coupling immediately disconnects, valves automatically seal both ends of line. Can be mounted to disconnect automatically where fluid lines may be subject to sudden, damaging strain.



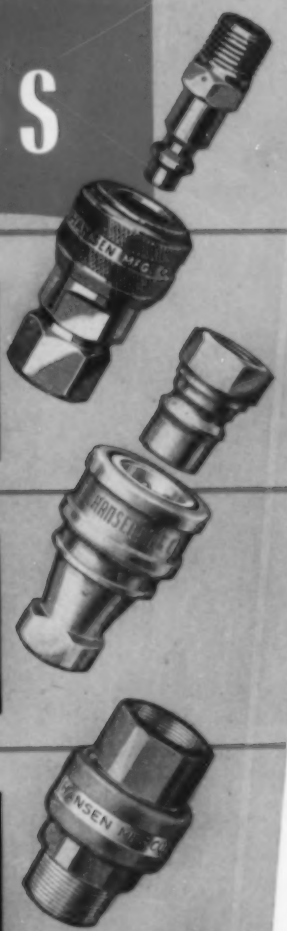
Series HP 8000

HANSEN STRAIGHT-THROUGH COUPLING

Provides quick connection and disconnection, but does not have shut-off feature. Size range for general use from ¼" to 2½". Two special types of straight-through steam couplings also available—one for low pressures, and one for high pressures.



Series ST Straight Through Coupling



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WRITE FOR CATALOG No. 47
giving descriptions and sizes of complete Hansen line of straight through and shut-off couplings for hydraulic and pneumatic connections.

QUICK CONNECTIVE FLUID LINE COUPLINGS...

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 11, OHIO

"In three weeks, we're going to start re-ringing our big units at the rate of one a week," said the Chief Engineer. "We can't afford any delays. How fast is Cook on piston rings deliveries?".

"We'll meet any deadline you want to set," said the Cook field man, "even if we have to burn the midnight oil to do it!".

This was an actual experience — one of many that Cook's corps of trained engineers meet every day. And, we're happy to relate that the Chief got his deliveries in plenty of time to maintain his orginial overhaul schedule.

Not all delivery problems are as simple as this, but wherever possible Cook can and does provide operators with fast, prompt service on any industrial size piston ring requirements. Cook does this by maintaining a large stock of standard size rings for immediate delivery and by providing rapid processing of special orders for quick shipment. Streamlined facilities—new production methods—and fast modern equipment make this possible.

Yes, you can rely on fast delivery from Cook, just as strongly as you can rely on better performance, longer life, and less cylinder wear from Cook Graphitic Iron Rings. Thus, if you need piston rings, either now or in the future, it will pay you to get in touch with Cook. A call or a letter to the office nearest you will do.

C. Lee Cook Mfg. Co., Inc., Louisville, Ky.
Branch Offices in Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, New Orleans, New York, San Francisco, Tulsa

COOK
GRAPHITIC IRON
PISTON RINGS

. . . SEALING PRESSURES SINCE 1888 . . .

FOOT OPERATED CONTROL VALVES

For better, faster production...

● Ideally used with shears, presses, forging machines and other machinery of all kinds because the operator has both hands free to handle the work. The U-shaped packers are expanded by pressure and seal tightly. All parts are in pressure balance avoiding any tendency to creep or crawl. There is no lapping—no grinding—no metal-to-metal seating. ⅜"; ½"; ¾" and 1" sizes. 3-way neutral position or regular actions.

Write for complete specifications—Today!

For maximum efficiency—and satisfaction—specify

Quick-As-Wink

AIR AND HYDRAULIC CONTROL VALVES

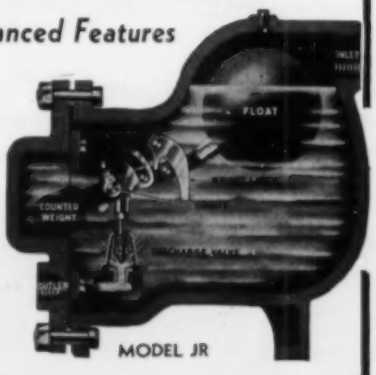
Mfd. by C. B. HUNT & SON, INC., *Salem, Ohio*

ENGINEERING AND SALES REPRESENTATIVES IN THE PRINCIPAL CITIES

Nicholson Air Traps Assure

POSITIVE DRAINAGE OF AFTERCOOLERS

by 2 Advanced Features



MODEL JR

1) Positive Fluid Seal Over Discharge Valve—As a result of this feature Nicholson traps are increasingly specified wherever loss of air is a problem in drainage of aftercoolers, intercoolers, separators, receivers, etc.

2) Extra Large Discharge Capacity—Valve opens wide instantaneously to discharge water, oil and dirt, after which it closes tight—instantaneously.

OTHER TROUBLE-PROOF FEATURES Non-wire drawing; not dependent on float to raise valve; of stainless steel where it counts, to prevent corrosion; rugged, for unavoidable abuse. 3 types for press. to 1500 lbs.

Catalog 448 or see Sweet's

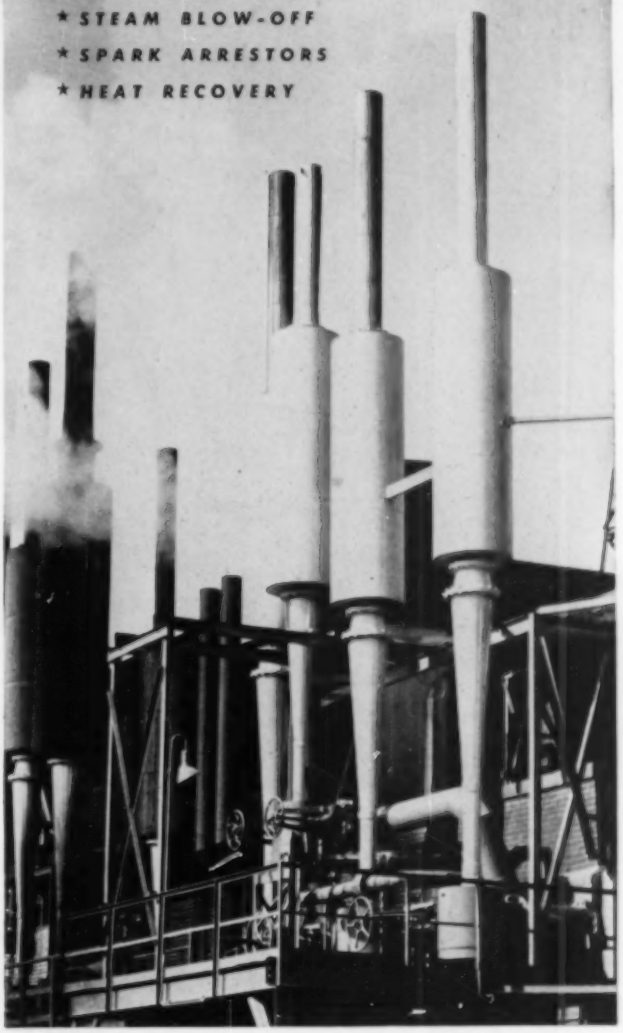
W. H. NICHOLSON & CO. 180 OREGON STREET WILKES-BARRE, PA.

Valves ★ Traps ★ Steam Specialties

MAXIM MAKES

A COMPLETE LINE OF SILENCERS FOR INDUSTRIAL USE

★ INTAKE
★ EXHAUST
★ STEAM BLOW-OFF
★ SPARK ARRESTORS
★ HEAT RECOVERY



THE MAXIM SILENCER COMPANY
61 HOMESTEAD AVE. HARTFORD 1, CONN.

Please send me literature on the following silencers:

☐ intake ☐ exhaust ☐ steam blow-off
☐ spark arrestors ☐ heat recovery

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DR. SHUSH

BE SURE IT'S A MAXIM

A *Still-Better* REGULATOR FOR Ingersoll-Rand CROWN AIR AIR POWER *Compressors*

A New *Floating-Speed* Regulator for DRILL-MORE CAPACITY CONTROL

The UL-83 *Floating-Speed* DRILL-MORE Regulator retains all the advantages of Ingersoll-Rand's *original* Multi-Speed DRILL-MORE control for portable compressors, and provides many other superior features.

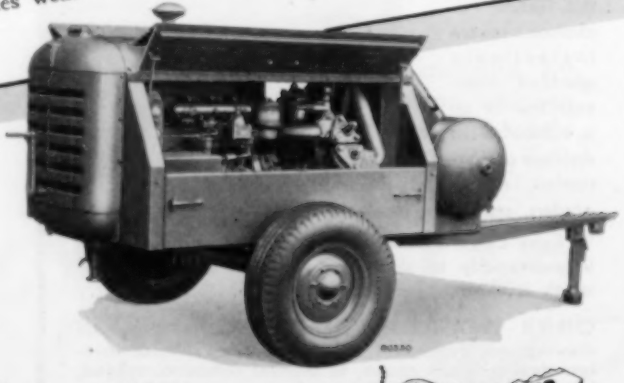
It automatically sets the exact and lowest practical compressor speed that delivers just enough air to maintain a constant air pressure. The speed "floats" with the demand for air.

- **Saves up to 40% in Fuel** by eliminating wasteful idling and always compressing the needed air at the slowest possible speed.
- **Holds 15- to 20-psi Higher Air Pressures.**
- **Up to 30% More Drill Power** . . . More Work from air tools.
- **Floating-Speed** . . . Eliminates speed steps . . . saves still more fuel.
- **Easier to Adjust** . . . Fewer parts . . . simpler in operation.
- **Compressor Loads and Unloads Only at Low Speed** and after reloading, speeds up only as much as needed . . . saves fuel, reduces wear and tear.
- **Reduces Maintenance** . . . Slower average compressing speed . . . unloaders operate fewer times . . . longer life of all parts.
- **Controls Engine Governor Instead of Carburetor** . . . Automatically compensates for temporary irregularities and prevents stalling.
- **Automatically Holds Engine at Low Speed During Starting** . . . Eliminates hand adjustments.
- **Ideal for Parallel Operation** of *unlimited* number of machines discharging into a common header.

and it gives you full rated capacity at 100 psi

Now standard on all KA-Series

105, 160, 210, 315 and 500-cfm sizes



DON'T STOP WITH A GOOD COMPRESSOR!

Use the IR CONTRACTORS' COMBINATION

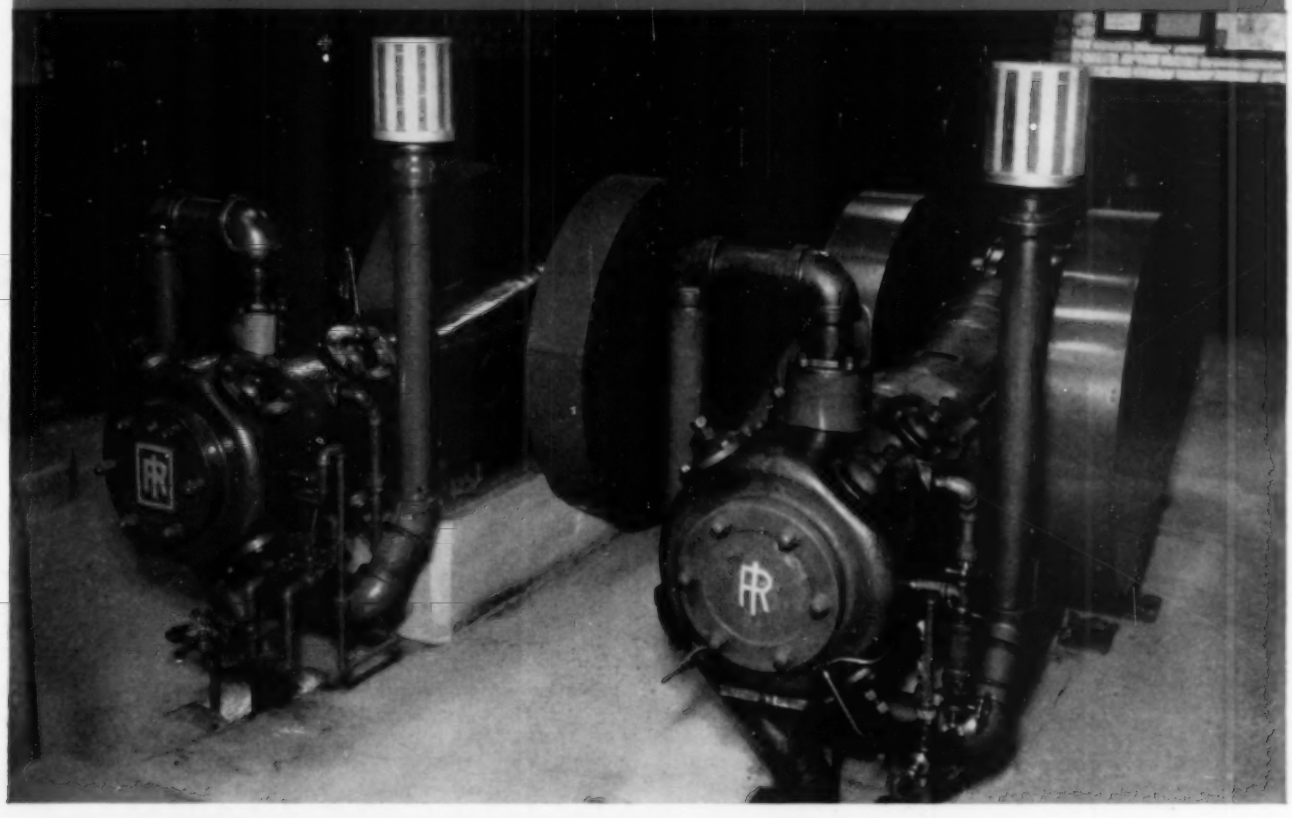
- Everything you need for rock drilling.
- Top quality machines that work as a team.
- Machines designed, built, sold, and serviced by men who know rock excavation . . . application "know how"

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 414-2

AIR POWER *The Key to Lower Costs*

Compressed air helps keep DEMOCRACY working



Tapered Roller TIMKEN BEARING EQUIPPED

The two Ingersoll-Rand 8" x 9" ES-1 air compressors pictured above are installed in the plant of an automatic voting machine manufacturer.

To help keep them operating smoothly, steadily and economically, Ingersoll-Rand selected Timken tapered roller bearings for the job of keeping the crankshaft free from friction and wear; holding it in alignment; and protecting it against radial, thrust and combined loads.

Ingersoll-Rand Company has had a lot of experience with Timken bearings in portable and stationary compressors; knows they can be depended upon for tip-top performance.

When buying anti-friction compressors of any kind make sure they are "Timken bearing equipped" for best results.

THE TIMKEN ROLLER BEARING COMPANY
CANTON 6, OHIO **Cable Address "TIMROSCO"**

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

TIMKEN 1899 50 1949 YEARS

Smoothing the Path of Progress for 50 Years

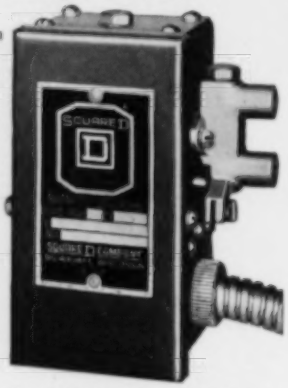
NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

New MAGNETIC UNLOADER

CLASS 9045 TYPE BG

Provides POSITIVE unloading of air-compressor at end of operation or when voltage failure occurs

FEATURES



- Release valve is located conveniently on the side of the unloader enclosure. Moisture, condensed by the rapid expansion of the unloaded air, is blown into the atmosphere. The solenoid coil and interior working parts remain dry and free of moisture.
- Coils are available for use with all standard voltages and frequencies. Dual voltage coils are commonly furnished in 110/220 V and 220/440 V ratings.
- Magnetic unloaders can be furnished with either two-way or three-way valves. The two-way valve exhausts the air between check valve and compressor head directly into the atmosphere. The three-way valve serves as an auxiliary valve to provide actuating air for a compressor unloader.

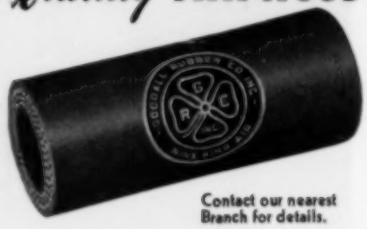
Write for Bulletin 9045, Square D Company, 4041 N. Richards Street, Milwaukee 12, Wis.

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

Cut Drilling Costs Three Ways ... With "MINE KING" *"Standard of Quality"* AIR HOSE

1. Lower hose replacement costs. "Mine King" is built to stay on *the job longer, under severest* working conditions.
2. Fewer connecting points and couplings. "Mine King" is available in extra long lengths.
3. Easier handling. Extreme flexibility facilitates drilling in "tight" spots and coiling for transport.



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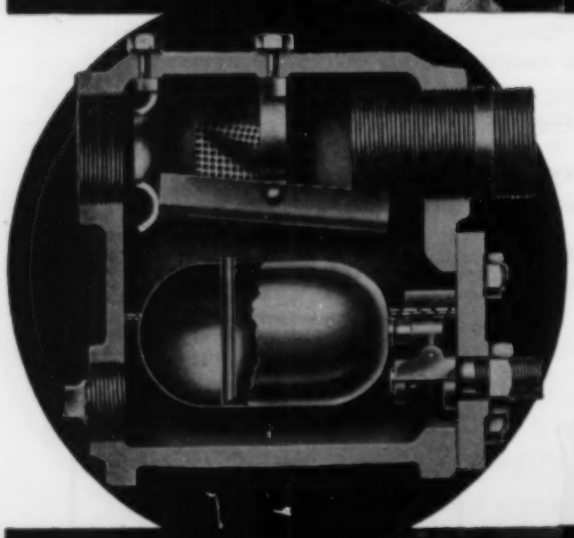
Est. 1870

DRI AIR MAY BE INSTALLED BY SUSPENDING IT FROM THE PIPING WITHOUT ANY OTHER SUPPORT.

INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



PROTECT EQUIPMENT WITH

DRIAIR

SEPARATES • COLLECTS • DELIVERS

• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.

"SPECIALISTS IN COMPRESSED AIR DEVICES"

PLAINFIELD, NEW JERSEY

GET THE *Drop* ON AIR-TOOL WEAR!

NORGREN air-line LUBRICATORS automatically feed controlled drops of oil into the air stream — diffusing each drop into an air-oil FOG that coats every part of the tool mechanism. Air tool wear is reduced—corrosion is stopped.

Write C. A. Norgren Co.,
222 Santa Fe,
Denver 9, Colo.

PROVED BY 20 YEARS' SERVICE!

Norgren

Also
- Regulators
- Filters
- Valves
- Hose Assemblies

2 Engines are Better than 1

This NEW Vegetable Harvester Is Powered by 2 WISCONSIN Heavy-Duty *Air-Cooled* ENGINES!

Harvesting onions and other vegetables mechanically is a NEW idea for a NEW machine . . . The Dilts-Wetzel (Ithaca, Mich.) Vegetable Harvester, powered by TWO Wisconsin Heavy-Duty Air-Cooled Engines...one driving the unit...the other powering the harvesting mechanism.

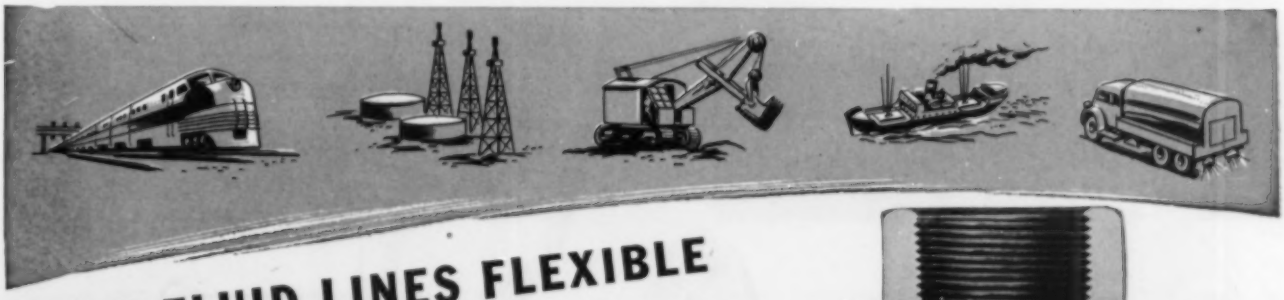
Peak efficiency and flexibility are always delivered, because the harvesting engine operates at uniform speed, regardless of the forward travel speed, and it shuts down entirely when moving to new locations. Furthermore, TWO Wisconsin Engines weigh less, cost less, use less fuel, and have lower part replacement costs than one large engine of comparable total horsepower.

Perhaps this offers an idea that can be advantageously applied to your equipment — for greater power, flexibility, efficiency, and economy. Your investigation is invited.

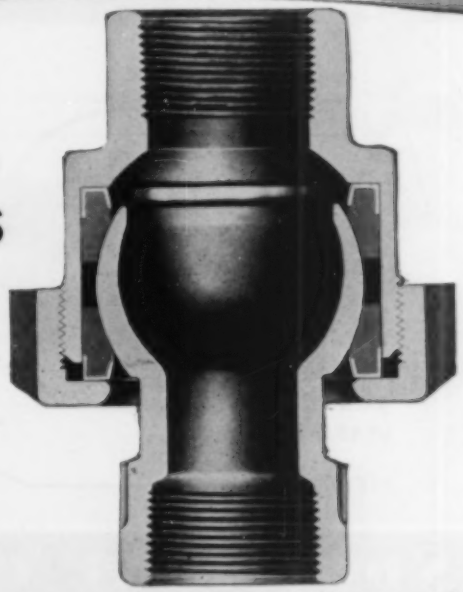
2 to 30 hp., single-cylinder, two-cylinder, and V-type four-cylinder models.

MOST H.P. HOURS

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 14, WISCONSIN, U. S. A.
Cable Address: "WISMOTORCO"



KEEP FLUID LINES FLEXIBLE WITH BARCO JOINTS



Operators of air, steam or hydraulic equipment find it necessary to have flexibility in their pipe lines to move the equipment while operating, or to take care of vibration, and prevent pipe breakage. There is no better way to accomplish this purpose than by the use of BARCO FLEXIBLE JOINTS, in connection with steel pipe. This combination will stand temperature, pressure, and abuse, which no other form of container will stand.

Millions of BARCO Joints are in service all over the world, and they will give you just as good service as they have given others. Ask for technical information on your specific problems, together with prices and recommendations. Write Barco Mfg. Co., 1837 Winnemac Ave., Chicago 40, Ill. In Canada: The Holden Co., Ltd., Montreal, Canada.

BARCO FLEXIBLE JOINTS

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

Not just a swivel joint ...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

"MOVE IN EVERY DIRECTION"

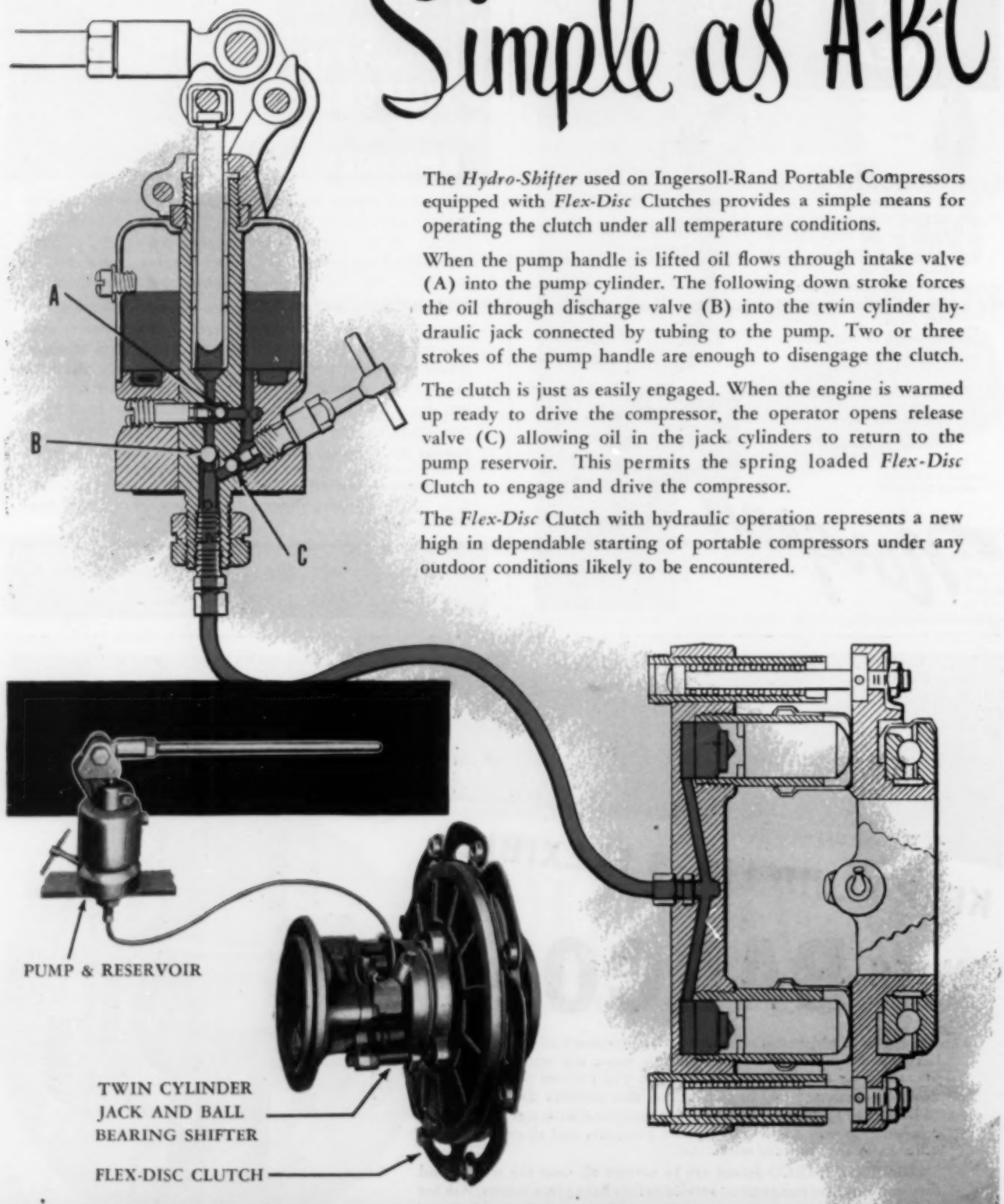
Simple as A-B-C

The *Hydro-Shifter* used on Ingersoll-Rand Portable Compressors equipped with *Flex-Disc* Clutches provides a simple means for operating the clutch under all temperature conditions.

When the pump handle is lifted oil flows through intake valve (A) into the pump cylinder. The following down stroke forces the oil through discharge valve (B) into the twin cylinder hydraulic jack connected by tubing to the pump. Two or three strokes of the pump handle are enough to disengage the clutch.

The clutch is just as easily engaged. When the engine is warmed up ready to drive the compressor, the operator opens release valve (C) allowing oil in the jack cylinders to return to the pump reservoir. This permits the spring loaded *Flex-Disc* Clutch to engage and drive the compressor.

The *Flex-Disc* Clutch with hydraulic operation represents a new high in dependable starting of portable compressors under any outdoor conditions likely to be encountered.



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GREATER POWER OUTPUT ...AT LOWER COSTS

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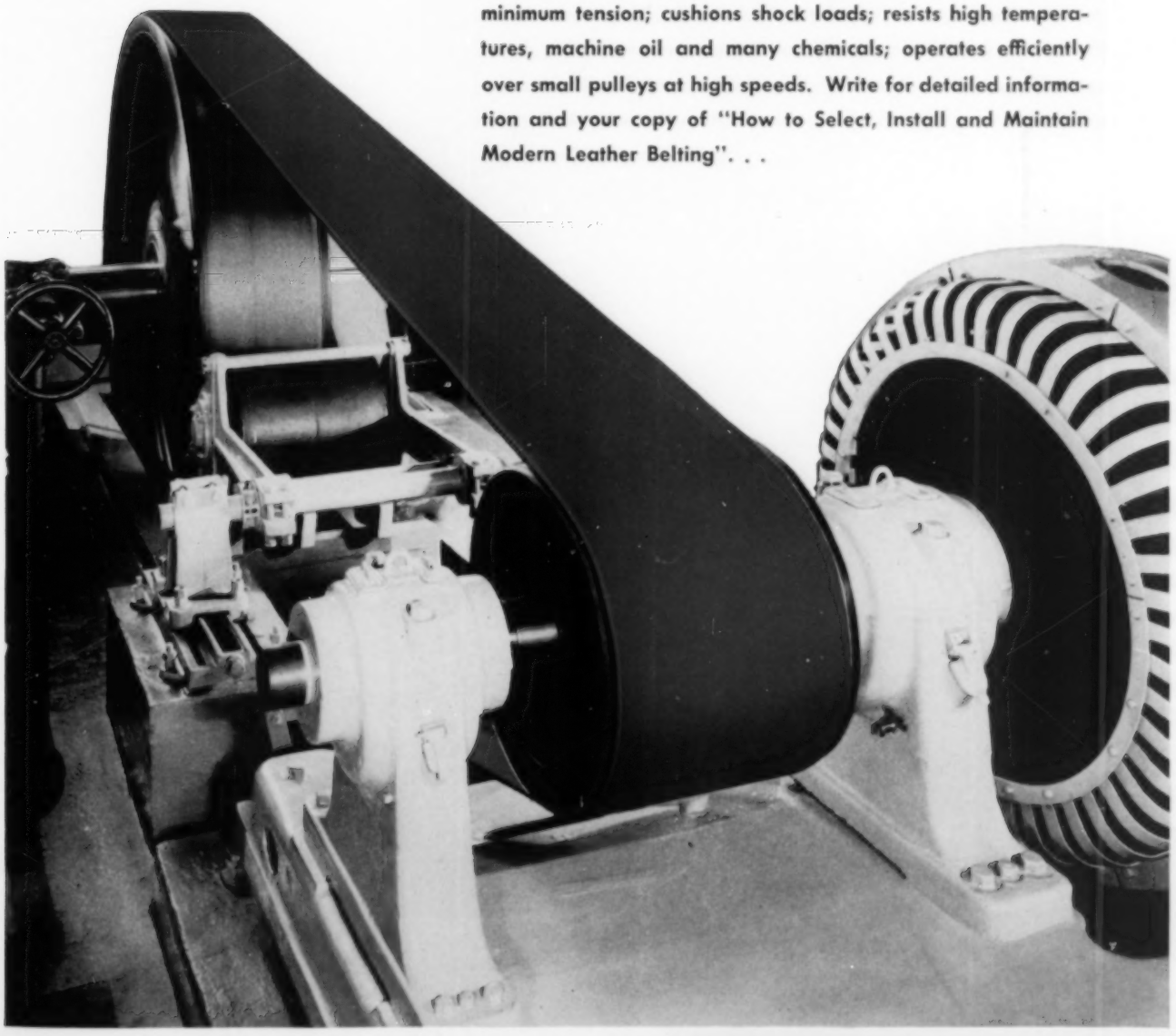
TANNATE helps increase production and lower maintenance costs . . . because **TANNATE** provides maximum grip with minimum tension; cushions shock loads; resists high temperatures, machine oil and many chemicals; operates efficiently over small pulleys at high speeds. Write for detailed information and your copy of "How to Select, Install and Maintain Modern Leather Belting". . .



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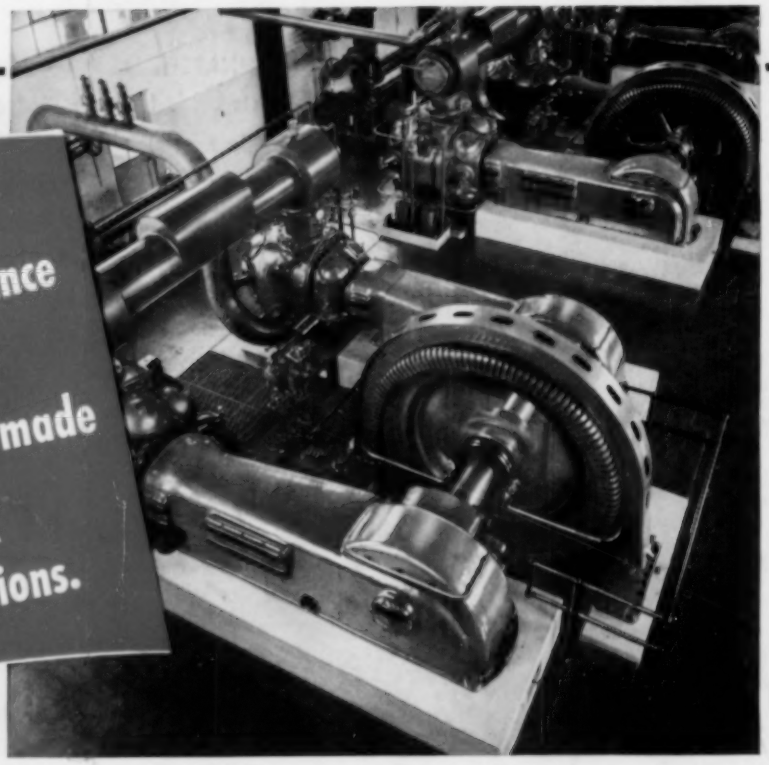
KEEP OUT RUST AND WEAR



ASSURE better compressor performance with the Texaco air compressor oils made to meet your operating conditions.

No guesswork when you lubricate with Texaco air compressor oils. There is a complete line of them so that, *regardless of your operating conditions,* you can be sure of clean valves, free rings, open ports and clear air lines. Here's the setup—

For regular service, Texaco straight mineral oils.

For water conditions, Texaco compounded oils.

For rust prevention, Texaco rust-inhibited oils.

For severe service and elimination of carbon and gum troubles, Texaco heavy-duty oils.

All are designed to give you greater operating efficiency . . . prolong compressor life . . . reduce your maintenance costs.

To be sure of getting the right lubricants for your compressors, let a Texaco Lubrication Engineer help you select them. Just call the nearest of the more than 2300 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd St., New York 17, N. Y.

TEXACO

TEXACO Air Compressor Oils

FOR ALL OPERATING CONDITIONS